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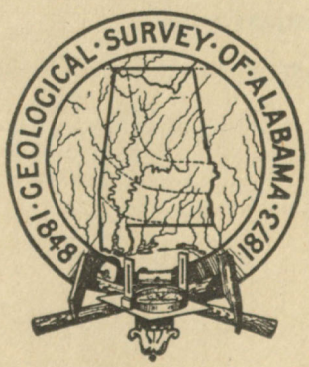
GEOLOGICAL SURVEY OF ALABAMA
EUGENE ALLEN SMITH, *State Geologist*

BULLETIN NO. 19

STATISTICS OF THE MINERAL PRODUCTION OF ALABAMA FOR 1915

COMPILED FROM THE MINERAL RESOURCES OF THE UNITED STATES

By
EUGENE A. SMITH



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LETTER OF TRANSMITTAL

UNIVERSITY, ALA., March 20, 1917.

HON. CHARLES HENDERSON,

Governor of Alabama,

Montgomery, Ala.

SIR:—I have the honor to transmit herewith the manuscript of a Report on the Mineral Production of Alabama for the year 1915 with the request that it be printed as Bulletin No. 19 of the Geological Survey of Alabama.

Very respectfully,

EUGENE A. SMITH,

State Geologist.

GEOLOGICAL CORPS.

Eugene Allen Smith, Ph. D.	State Geologist
William F. Prouty, Ph. D.	Chief Assistant
Robert S. Hodges	Chemist
Herbert H. Smith	Curator of Museum
Roland M. Harper, Ph. D.	Botanist
A. T. Donoho	Stenographer
Geo. N. Brewer	Field Assistant

RIVER GAGE HEIGHT OBSERVERS.

A. L. Stowe	Jackson's Gap, Tallapoosa River
J. E. Whitehead	Riverside, Coosa River
A. W. Lambert	Beck, Conecuh River
Ed. Bullen	Red Bay, Big Bear Creek

From the records of daily observations of the gage readings at these places when extended through sufficient time, the calculation of available horsepower to be obtained from the different streams is made.

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PREFACE

The statistics of all the minerals included in the following pages have been collected in coöperation with the United States Geological Survey, and have been compiled from advance chapters of the *Mineral Resources of the United States,* a publication of the Federal Survey.

The introductory and general matter in each of these articles has either been taken without change from the U. S. advance chapters or has been rearranged or condensed from these chapters, or entirely rewritten to suit it to our present purposes. In each case credit is given to the author.

INTRODUCTION

EUGENE A. SMITH.

AN INSPECTION of the subjoined table will show that there has been in 1915 an increase both in quantity and value of cement, clay, graphite, iron ore, pig iron and lime, with a slight decrease in the valtue of clay products; a decrease both in quantity and value of coal, gold, silver and mineral waters; an increase in quantity but decrease in value, of sand and gravel and stone, and a slight decrease in quantity but increase in value of coke.

Following the plan set out by Mr. E. W. Parker in 1913, and continued by the Alabama survey, we pass in review the production in 1914 and 1915 of Alabama minerals, and their immediate derived products, taking them up somewhat in the order of their commercial importance.

Coal.—Alabama's production of coal in 1915 was 14,927,937 short tons, valued at $19,066,043, a decrease of 4.3 per cent in quantity, and 8.6 per cent in value as compared with 1914. As in 1914, the value of the coal product of Alabama in 1915 was approximately two-thirds of the total mineral output of the State.

Coke.—The coke production of Alabama decreased from 3,084,149 short tons, valued at $8,408,443 in 1914, to 3,071,811 tons, valued at $8,545,555 in 1915, an increase in the value of $137,112, or 1.6 per cent.

Iron Ore.—There was in 1915 an increase of 13.7 per cent in the total quantity of iron ore production, 16.9 per cent in the quantity of the hematite, and 1.1 per cent in the quantity of brown ore.

In the quantity of pig iron marketed in Alabama in 1915, there was an increase from 1914 of 39.6 per cent, and an increase of 35.9 per cent in the value.

The value of this iron ore production, and not the value of the pig iron, is used in making up the total value of the mineral products of the State.

The total value of the mineral production of Alabama, excluding the value of the pig iron and coke and including the value of the iron ores and the coal, was $29,457,407 in 1915, compared with $30,879,288 in 1914, of which as already stated, approximately two-thirds is represented by the products of the coal mines. Nearly one-fourth of the total value was contributed by the iron mines. The decrease in 1915 from 1914 was $1,421,881, or 4.6 per cent.

The principal coal producing counties are Jefferson, Walker, Bibb, Tuscaloosa, and St. Clair, in the order named. The principal iron ore counties are Jefferson, Tuscaloosa, Franklin, and Etowah. The combined value of the pig iron and coke made in Alabama in 1915, was $32,302,679. These values are not included in the total as they are represented in the value of the iron ore and coal produced.

Clay-Working Industries.—These industries yielded products in 1915 valued at $1,193,022, against $1,574,023 in 1914, a decrease of $381,001 or 24.2 per cent. This does not include the value of the raw clay sold, which in 1915 amounted to $35,232, an increase from 1914, or 1.8 per cent.

The center of the clay-working industry is Jefferson county, and Birmingham furnishes the principal market. Vitrified, front, and fire brick, represent a value of $578,134, or 151.3 per cent of the value of the common brick, while the total output of the brick yards makes up over 80 per cent of the State's total clay products. All the fire brick is reported from Jefferson and Calhoun counties and all the vitrified brick is from Jefferson county. Clay pits for the manufacture of common brick have been opened in one or more places in thirty different counties.

Stone.—The quarry products, the larger part of which is limestone, were valued in 1915 at $719,452, a decrease of 45.4 per cent, from $1,319,753 in 1914.

The decreased production in 1915 was in the output of limestone, for rough building stone, road making, flux, concrete, and for agricultural purposes: for sandstone used for rough building purposes; and the production of marble.

Over 59 per cent of the total value of the stone production is limestone. Its most important uses are for furnace flux, concrete, road making, for building purposes and for agricultural uses. Until 1914 comparatively little of Alabama limestone

was used for building purposes, but there has been in 1915 a decrease of 46 per cent along this line. In the production of marble there has also been a notable decrease in 1915. The reader is referred to the body of this Bulletin, under Stone, for further details concerning especially, the building stones and marble industries.

Marble holds the second place in the value of quarry products, a beautiful white marble, occurring in Coosa and Talladega counties, being extensively used for building (both inside and outside work), and a black marble which gives promise of future development, has been prospected near Anniston and near Piedmont.

Cement.—The cement production of Alabama amounted in 1915 to 1,114,386 barrels, valued at $891,483, as against 777,698 barrels in 1914, valued at $746,555, an increase of 43.3 per cent in quantity, and of 19.4 per cent in value.

Lime.—The lime production is not included in that of the limestone, and amounted to 60,332 short tons, an increase from the 1914 production, of 13,366 short tons, or 24.8 per cent. The value of the product was $250,227, an increase of $50,413, or 25.2 per cent.

Graphite.—The Alabama graphite is all of the crystalline variety, and the value of the product in 1915 was $204,572, as against $118,000 in 1914, an increase of 44.2 per cent. The Alabama production for 1915 was 49 per cent of the total value of the crystalline graphite produced in the United States, and 47.6 per cent of the total value of amorphous and crystalline combined. The great increase in production in 1915, and the installing of a number of new plants, not in active operation in 1915, make it probable that the Alabama production in 1916 and following years, will represent an even larger proportion of the U. S. total value.

Minor Products.—Alabama produces a small quantity of gold and silver, and other minor products are bauxite, mica, millstones, mineral paints, (natural pigments), mineral waters, natural gas, sand and gravel, and quartz.

In the following table is represented a comparison of the mineral output of Alabama in 1914 and 1915. As stated above, the total does not include the value of pig iron or that of coke, but it does include the value of the coal made into coke, and of the iron ore sold or used.

Mineral production of Alabama in 1914 and 1915.

Product.	1914				1915			
	Raw.		Derived.		Raw.		Derived.	
	Quantity.	Value.	Quant'y.	Value.	Quantity	Value.	Quantity.	Value.
Barytes, short tons	(*)	(*)	.....	.....	(*)	(*)	.....	.....
Bauxite, long tons	(*)	(*)	.....	.....	(*)	(*)	.....	.....
Cement, barrels	.....	.....	777,698	$746,555	.....	.....	1,114,386	$891,483
Clay products, short tons	27,973	†$34,607	.....	1,574,023	31,870	†$35,232	.....	1,193,022
Coal, short tons	15,593,422	20,849,919	.....	.....	14,927,937	19,066,043	.....	.....
Coke, short tons	.....	.....	3,084,149	†8,408,443	.....	.....	3,071,811	†8,545,555
Ferro-alloys, long tons	.....	.....	(*) (†)	(*) (†)	.....	.....	(*) (†)	(*) (†)
Gold, fine ounces (troy)	.....	.....	579	11,970	.....	.....	254	5,243
Graphite, crystalline, pounds	2,410,200	118,000	.....	.....	3,474,800	204,572	.....	.....
Iron ore, long tons	4,514,926	5,727,619	.....	.....	5,134,955	6,798,266	.....	.....
Iron, pig, long tons	.....	.....	1,661,420	†17,481,828	.....	.....	2,320,255	†23,757,124
Lime, short tons	.....	.....	46,966	199,814	.....	.....	60,332	250,227
Manganese ore, long tons	.....	.....	.....	.....	200	(*)	.....	.....
Mica	.....	.....	.....	(*)	.....	.....	.....	5,940
Millstones	.....	.....	.....	(*)	.....	.....	.....	.....
Mineral paints, natural pigments, short tons	.....	.....	(*)	(*)	.....	.....	(*)	(*)
Mineral waters, gallons sold	169,279	17,125	.....	.....	86,499	8,912	.....	.....
Natural gas	.....	(*)	.....	.....	.....	(*)	.....	.....
Sand and gravel, short tons	831,430	262,219	.....	.....	924,701	242,336	.....	.....
Silver, fine ounces (troy)	.....	.....	199	110	.....	.....	12	6
Stone	.....	(‡)	.....	‡1,319,753	.....	(‡)	.....	‡719,452
Miscellaneous	.....	42,382	.....	336,325	.....	68,561	.....	571,592
Total value, eliminating duplications	$30,879,288				$29,457,407			

*Value included under "Miscellaneous." †Value not included in total value. ‡Stone sold rough included in derived products.

STATISTICS OF THE MINERAL PRODUCTION OF ALABAMA FOR 1915

ABRASIVES.

EUGENE A. SMITH.

ALABAMA'S production of abrasives is at present limited to a small number of millstones (chasers*) quarried and made at Dutton, Jackson County; there are, however, several materials in different parts of the State which are sufficiently promising to be worth investigating and thorough testing; the nature and locality of these deposits were treated in Bulletin No. 13, which see.

BARYTES.

(Condensed from Mineral Resources of the United States.)

JAMES M. HILL.

ALABAMA again entered the list of producers of barytes in 1915. One deposit in Calhoun County was worked and it is authoritatively reported that a deposit near Leeds, Jefferson County, will be exploited during 1916. The 1915 output was sold to manufacturers of lithopone. On account of small number of producers the exact figures of 1915 production cannot be given.

*Chasers are larger than the regular millstones. They are used for heavier work, such as grinding quartz, feldspar, barytes, etc., and they run on edge. Though they are made with a diameter as short as 24 inches, they are usually turned out with diameters ranging from 50 to 84 inches, and are as much as 22 inches in thickness. These chasers are run on pans paved with roughly cubical blocks of the conglomerate, with edges about a foot in length. In grinding quartz in such pans the chasers are used in the preliminary crushing; then rough blocks, usually three in number, are either attached to or carried along by lateral arms, which in turn are joined to a vertical revolving shaft. By the circular movement of these blocks the material placed in the pan is ground to powder.

The commercial barytes deposits of Alabama[1] are of the residual type; most of the better-known deposits are located in the central and northeastern part of the State, including Bibb, Calhoun, Etowah, Jefferson, Shelby, and St. Clair counties. Lower Paleozoic rocks underlie parts of all these counties and the Knox dolomite (of Cambrian and Ordovician age) and the Chickamauga limestone (of Ordovician age) outcrop in them. These formations, from which the barite is derived, outcrop in narrow northeastward-trending bands, whose position is determined by the folding and faulting that formed the Appalachian Mountains. The more important deposits are near the contact of the two formations, though some deposits are found in residual clays derived entirely from the Knox dolomite. Barite-bearing veins are found in the dolomite and limestone. Alabama barite is of good quality, usually pure and white, but sometimes colored and iron-stained. The barite from some localities is associated with galena. The principal cause of the lack of development of the deposits in the past appears to have been the distance to grinding mills and other consumers.

The barytes deposits of Alabama which have thus far been developed are in clays derived from the weathering of limestones and dolomites of Cambrian and Ordovician age. The barytes in the residual deposits was originally in veins or replacements in the limestone rocks. Owing to the slight solubility of the barytes and the silica (quartz and chert), these minerals resisted the agencies of weathering and were left behind with the clay upon the removal of the soluble constituents of the original formation.

The distribution of the barytes in the original rocks seems to have been influenced largely by the presence of openings through which solutions carrying barium could penetrate.

Thus, in Alabama and some other states the barytes deposits are located along or near zones of folding and faulting of the late Cambrian and Ordovician rocks.

---

1 Butts, Charles, U. S. Geol. Survey Geol. Atlas, Birmingham folio (No. 175), 1910.

Grasty, J. S., Mineral resources of the South; Barite deposits of Alabama; The Tradesman, July 13, 1913, pp. 35-36.

Hayes, C. W., U. S. Geol. Survey Geol. Atlas, Gadsden folio (No. 35), 1896.

Smith, E. A., Report of progress for 1875, p. 95, Alabama Geol. Survey, 1876.

Smith, E. A., and McCalley, Henry, Index of the mineral resources of Alabama, pp. 62-63, Alabama Geol. Survey, 1904.

Watson, T. L., and Grasty, J. S., Barite of the Appalachian States: Am. Inst. Min. Eng. Bull. 98, pp. 351-353, February, 1915.

Barium Products.

For many years ground and floated barytes has been produced at various plants located in Kentucky, Missouri, North Carolina, South Carolina, Tennessee, and Virginia. Prior to 1914 a small quantity of barium chemicals was made in the United States, though there is little published information relative to this industry. It would appear that practically all the barium chemicals heretofore used were imported either from Germany, England, or France. In each of those countries there were barium chemical plants, though the industry was apparently most highly developed in Germany and England.

The Manufacture of Ground Barytes.[1]

The treatment of crude barytes to make ground barytes varies in different plants. The general practice. however, seems to be to crush to about 1 inch and log-wash and jig to remove clay, calcite, flourite, silica, and part of the iron oxide. This cleaned material is next crushed to one-fourth to one-eighth inch at some plants, and at others ground fine and subjected to a bleaching process. The bleaching, largely to remove iron oxide, is accomplished by treating the material with sulphuric acid from 8 to 12 hours in lead-lined wooden tanks. The bleached product is washed several times and ground in burr mills or pulverizers to pass 200 to 300 mesh, and in some plants is water floated to insure a uniformly fine product, and is then dried, pulverized, and packed. Much care is required not only in the bleaching, but also in the drying operation to insure a uniformly perfect color. Details of the manipulation during bleaching and of the drying machinery are not made public.

The softer grades of barytes are preferred by the grinders, as there is less wear on the machines in treating this class of material. However, in some plants, hard crystalline barytes is ground successfully. Several grades of ground barytes are on the market, varying from unbleached, coarsely-ground

1 The sections of this report dealing with the manufacture of barium products have been read and criticised by Mr. Hugh Rollin, of the Rollin Chemical Co., and Mr. Maximilian Toch, of the Durex Chemical Co., to whom the Survey desires to express its appreciation for their courtesy.

material to the finest grade of white-bleached and water-floated pigment. The following list includes all the companies reporting a production of ground barytes:

Barbour Chemical Works, 707 West Coast Life Building, San Francisco.
Carolina Chemical Co., Stackhouse, N. C.
Cherokee Chemical Co., 109 Hollingsworth Street, Baltimore, Md.
Elkhorn Chemical Co., Elsinore and Gilbert Avenues, Cincinnati, Ohio.
J. C. Fink Mineral & Manufacturing Co., 101 Barton Street, St. Louis, Mo.
Nulsen, Klein & Krausse Manufacturing Co., Levee and Sidney Streets, St. Louis, Mo.
Point Milling & Manufacturing Co., Mineral Point, Mo.
Product Sales Co., 423-425 Equitable Building, Baltimore, Md.
Thompson, Weinman & Co., 100 William Street, New York, N. Y.

The Manufacture of Lithopone.

Lithopone is a mixture of approximately 70 per cent barium sulphate, 25 to 29 per cent zinc sulphide, and 1 to 5 per cent zinc oxide, which is made by mixing hot solutions of barium sulphide and zinc sulphate. In the preparation of high-grade lithopone the solutions of barium and zinc compounds must be essentially pure. The precipitate from the tanks is filter-pressed, dried, subjected to considerable heat, quenched in water, ground to pulp, filter-pressed, dried, and packed for shipment. A recent paper by O'Brien* brings out the important points in the preparation of lithopone and indicates some of the features necessary to produce a light-proof product. Lithopone is sold under a great variety of trade names, such as Beckton White, Green Seal, Blue Seal, Sterling White, Fulton White, Phonolith. The following list includes the manufacturers who reported production in 1915 or prospective production in 1916:

Beckton Chemical Co., 3500 Grays Ferry Road, Philadelphia, Pa.
Grasselli Chemical Co., Cleveland, Ohio.
N. Z. Graves Corporation, 22-24 South Third Street, Philadelphia, Pa.
Krebs Pigment & Chemical Co., Newport, Del.
Mantua Chemical Co., 3500 Grays Ferry Road, Philadelphia, Pa.
Midland Chemical Co., 80 East Jackson Boulevard, Chicago, Ill.
New Jersey Zinc Co., 55 Wall Street, New York, N. Y.

*O'Brien, W. S., A Study of Lithopone: Journal of Phys. Chem., Vol. 19, pp. 113-144, 1915.

The Manufacture of Barium Chemicals.

The principal barium chemicals made in the United States are the binoxide, carbonate, chloride, hydroxide, nitrate, and sulphate or blanc-fixe. Some crude barium sulphide ("Black Ash") is sold to makers of lithopone and manufacturers of chemicals who are not equipped to roast sufficient barytes to meet their needs.

The following companies reported to the U. S. Survey that they had made barium chemicals during 1915 or were about to begin the manufacture of one or more of the chemicals early in 1916:

Barbour Chemical Works, 707 West Coast Life Building, San Francisco, Cal.
Baryta Manufacturing Co., 205 Pearl Street, New York, N. Y.
Chemical Products Co., 616 Majestic Building, Denver, Colo.
Chicago Copper & Chemical Co., 111 West Jackson Boulevard, Chicago, Ill.
Clinchfield Products Co., 120 Broadway, New York, N. Y.
Durex Chemical Co., 320 Fifth Avenue, New York, N. Y.
Elkhorn Chemical Co., Elsinore and Gilbert Avenues, Cincinnati, Ohio.
Globe Chemical Co., 1205 Regent Avenue, Cincinnati, Ohio.
Lamar Chemical Works, 44-56 Lewis Avenue, Jersey City, N. J.
Port Morris Chemical Works, 141 Locust Avenue, New York, N. Y.
Rollin Chemical Co., Charleston, W. Va.

Uses of Barium Chemicals.

Ground barytes of the lower unbleached grades is sold to manufacturing chemists and to paint manufacturers for incorporation in colored mixed paints; it can also be used in the preparation of rubber and in other industries where a colored product is made. The bleached and floated barytes of the finer grades is used as a white pigment in the preparation of ready mixed white paints and as a filler for the chemical pigments. In the paper industry it is largely used in the manufacture of heavy, stiff materials such as playing cards, bristol boards, and the like.

Lithopone is sold and used as a white pigment for ready mixed paints, being particularly used for the preparation of what are called the "sanitary flat wall paints," which are used to a large extent. It is also used in some enamels and calsomines, and in the rubber, paper, and cloth industries, where it is replacing barytes and some of the metallic pigments.

The barium chemicals have a wide variety of uses and may enter into the manufacture of other products. In the study of

the industry the products have not been followed beyond the plants at which the chemicals are made from crude barytes. Barium binoxide or peroxide (BaO_2) apparently finds its principal market with the manufacturers of hydrogen peroxide, though some is believed to be used in the preparation of oxygen. This salt has the property of giving up part of its oxygen under certain conditions and of recombining with more oxygen under reverse conditions. This property is not, however, everlasting, and fresh supplies of the peroxide are frequently required.

Barium carbonate is used in the preparation of other barium chemicals—in rat poisons, as a water softener, in the manufacture of flat wall paints, and in the ceramic industry. Probably the last is its largest use at present. It is said that this material will fill the requirements of case-carbonizing steel, which was formerly filled by ground bone. Ground bone, which formerly commanded a price of $60 a ton, has risen in price and the makers of case-carbonized steel have been in search of a substitute. The barium carbonate for this purpose must contain no sulphur, but may carry calcium and small amounts of other impurities. It is said that the demand should be several thousand tons a year.

Barium chloride is used in the preparation of other barium salts, as a water softener, a chemical reagent, particularly for the purification of table salt, to some extent in the ceramic arts, and in the preparation of rat poisons.

Barium hydroxide is used as a chemical reagent. It can be used in the refining of sugar, but on account of its poisonous nature is not often employed; another reason why it is not used is the difficulty of its regeneration from the carbonate which is formed by the reactions.

Barium monoxide has its principal use in the preparation of the binoxide and hydroxide. It is used to some extent in the manufacture of special glasses.

Barium nitrate is used as a chemical reagent in the preparation of "green fire" and green signal lights and in the manufacture of an explosive known as saxifragin.

Barium sulphate, usually sold under the name of blanc-fixe or permanent white, is a pigment extensively used in the paint industry, in the manufacture of highly glazed papers and of putty, and in the fabrication of rubber and of lake colors.

BAUXITE.

THE production of bauxite in Alabama for 1915 was limited to one producer, which accounts for the joining of the Alabama and Georgia totals.

The following table gives the production and value of bauxite from 1899 to 1915 inclusive:

Production of bauxite in the United States, 1889-1915, by States, in long tons.

Year.	Georgia.	Alabama.	Arkansas.	Total.	Value.
1889	728	.....	.....	728	$2,366
1890	1,844	.....	.....	1,844	6,012
1891	3,301	292	.....	3,593	11,675
1892	5,110	5,408	.....	10,518	34,183
1893	2,415	6,764	.....	9,179	29,507
1894	2,050	9,016	.....	11,066	35,818
1895	3,756	13,313	.....	17,069	44,000
1896	7,313	11,051	.....	18,364	47,338
1897	7,507	13,083	.....	20,590	57,652
1898	.....	.....	.....	25,149	75,437
1899	15,736	14,499	5,045	35,280	125,598
1900	19,739		3,445	23,184	89,676
1901	18,038		867	18,905	79,914
1902	22,677		4,645	27,322	120,366
1903	22,374		25,713	48,087	171,306
1904	21,913		25,748	47,661	235,704
1905	15,173		32,956	48,129	240,292
1906	25,065		50,267	75,332	368,311
1907	.....		.....	*97,776	480,330
1908	14,464		*37,703	52,167	263,968
1909	22,227		*106,874	129,101	679,447
1910	33,096		*115,836	148,932	716,258
1911	30,170		*125,448	155,618	750,649
1912	19,587	14,173	*126,105	159,865	768,932
1913	27,409		*182,832	210,241	997,698
1914	18,547		*200,771	219,318	1,069,194
1915	25,008		*272,033	297,041	1,514,834

*Production of Tennessee included.

The Republic Mining & Manufacturing Co. was the only one that operated in Alabama in 1914. The company worked near Rock Run, Cherokee County, in the eastern part of the State.

USES OF BAUXITE.

W. C. PHALEN.

The chief uses of bauxite are as follows: (1) As raw material in the production of metallic aluminum; (2) in the manufacture of aluminum salts; (3) in the manufacture of bauxite bricks; (4) in the manufacture of alundum (fused alumina) for use as an abrasive. The use of bauxite in the manufacture of calcium aluminate to give a quick set to plaster compositions should be added, as well as the extended use which alundum is finding in the refractory industries.

1. The use of bauxite in the production of metallic aluminum is by far the most important of those enumerated. A large part of the output of Arkansas is so used, and the figures of production from this State have shown remarkable growth during recent years. A large part of the imported French bauxite has also been used in the manufacture of metallic aluminum.

2. Only the purer bauxite is used in the manufacture of chemicals, such as alum, aluminum sulphate, and aluminum salts in general. For this use freedom from oxide of iron is essential.

3. Bauxite is used in the manufacture of bauxite bricks for furnace linings. The purer the bauxite used, the more refractory is the resulting brick; moreover, the addition of bauxite to refractory clays not only increases their content of alumina but also their refractoriness. The method of making bauxite brick, a representative analysis of them, and the troubles sometimes encountered in their use where set forth in Mineral Resources for 1913.

Kenneth Seaver[1] has discussed the use of alumina in making bauxite brick. The two kinds of brick in common use, made of hydrous oxide of aluminum, contain 56 and 77 per cent alumina, percentages which represent the extreme proportions of alumina of value in this industry. The characteristics of these two kinds of brick are quite different. The brick containing 56 per cent alumina is used as a fire-clay brick, but it will withstand higher heat. The brick containing 77 per cent alumina has been used as a substitute for magnesia brick, com-

1 Am. Inst. Min. Eng., December, 1915, pp. 2505-2506.

monly called magnesite brick, for open-hearth and similar work. It has given excellent results. Under normal conditions it probably can not be produced as cheaply as magnesite brick.

An instance is cited where bauxite brick were used in the port end of the furnace, forming a bulkhead for that particular open-hearth furnace for 365 heats, at the end of which time a new roof was installed. The opposite port, in which mangesia brick were used, was found in worse condition. There seem to be great possibilities connected with the use of alumina brick.

4. Bauxite is used on a large scale at Niagara Falls in the manufacture of the artificial abrasive alundum. This abrasive is made in the electric furnace by fusing calcined bauxite. It is high in crystalline aluminum oxide and virtually amounts to a form of artificial corundum. The quality of the product is under complete control and can be duplicated with ease for use in the various abrasive processes, a factor of great importance in any successful abrasive industry. Alundum is particularly efficient in the grinding of steel.

5. The application of bauxite in the manufacture of calcium aluminate to give a quick set to plasters is discussed in Mineral Resources for 1911.[2]

ALUMINUM.

W. C. PHALEN.

PRODUCTION AND CONSUMPTION.

THE United States leads the nations in the production of metallic aluminum, and the marked increase in production in the United States is well illustrated by the figures given in the accompanying table. These figures give production to 1903 and consumption of the metal since that year.

2 Phalen, W. C., Bauxite and aluminum; U. S. Geol. Survey Mineral Resources, 1911, pt. 1, p. 931, 1912.

Aluminum produced or consumed in the United States, 1885-1915, in pounds.

1885 283	1896 1,300,000	1907 *17,211,000
1886 3,000	1897 4,000,000	1908 *11,152,000
1887 18,000	1898 5,200,000	1909 *34,210,000
1888 19,000	1899 6,500,000	1910 *47,734,000
1889 47,468	1900 7,150,000	1911 *46,125,000
1890 61,281	1901 7,150,000	1912 *65,607,000
1891 150,000	1902 7,300,000	1913 *72,379,000
1892 259,885	1903 7,500,000	1914 *79,129,000
1893 333,629	1904 *8,600,000	1915 *99,806,000
1894 550,000	1905 *11,347,000	
1895 920,000	1906 *14,910,000	556,672,546

*Consumption. The figures for 1915 do not include the weights of imported leaf aluminum, valued at $1,294; table, kitchen, and hospital utensils, and other similar hollow ware, valued at $32,435; wire, valued at $39,021; and "All other manufactures" of aluminum, valued at $42,083.

The secondary aluminum produced in 1915 was 5,700 short tons; the recovered aluminum contained in alloys was 2,800 short tons.

Uses of Aluminum.

The rapid increase in consumption of metallic aluminum shows that the metal is gaining in favor on account of several of its inherent qualities, among which are lightness, comparative toughness, durability, and resistance to chemical corrosion. The fact that aluminum has been successfully soldered and welded enables it to take its place among the most useful of the metals. The outlook for metallic aluminum in the future is exceedingly bright.

Improvement in foundry methods for casting metallic aluminum, the result of long experience and of increased knowledge of suitable alloys, has made it possible for metallic aluminum to compete both with other sheet metals and with wood in the manufacture of automobile bodies. Large sections of aluminum castings are now in use in making touring cars and the inclosed bodies of certain other motor cars, which was not practicable 10 years ago. Cast aluminum is now also used for making automobile dashes. The advantages of aluminum construction are that bodies made of it are lighter than those made of other sheet metal and have a rigid surface which will not dent easily when handled. They are also safer in case of acci-

dent. The aluminum surface retains paint well, and the increased rigidity makes the car more durable.

The applications of metallic aluminum during the war in Europe have been many, and consequently the demand for it has been great. Duralumin, an alloy of aluminum containing 3 per cent of copper and 1 per cent of magnesium, has been extensively used in the manufacture of cartridges for rifles, shells, helmets, grenades, and, with soft iron, of shell fuses. In France its use in cartridges is said to have been abandoned, but there has been a great demand for it everywhere for camp equipment and in the construction of air craft of all kinds. In the United States its use in the manufacture of automobiles, air ships, and miscellaneous war supplies has been very great.

During the last few years steel-reinforced aluminum cables have come into use for overhead power lines. In the cable the aluminum wires are laid over a core of high-tensile steel, which bears the greater part of the strain when the cable is erected. The price of aluminum having become so high, it is reported that certain transmission lines in the United States have actually been replaced by copper wire with substantial financial gain. Reported thefts of aluminum wire attest the present value of the metal.

The uses of aluminum dust or powder have been mentioned in preceding reports. The powder is of value in metallurgy as a precipitant of the precious metals in the cyanide process. It is also used as a reducing agent, as in the Goldschmidt thermit process of welding. It is a constituent of bronze powder in the preparation of aluminum paint. One of the most interesting uses of aluminum dust at the present time is in the manufacture of explosives. Aluminum dust mixed with ammonium nitrate produces an explosive called "ammonal" that has given good results in mining and in shells. It has the advantage of being insensitive, is very stable, and is found to remain in good order for long periods.

Process of Producing Metallic Aluminum.

Greenville Mellen has patented a process for extracting aluminum from clay, kaolin, or aluminum silicates in general, which is as follows: The clay is fused with sodium sulphate in the presence of sulphuric acid, or with its equivalent of acid

sodium sulphate, in such proportion as to form aluminum sulphate and free silica. The fusion product after cooling is dissolved in water, filtered, and treated with sodium fluoride. The aluminum fluoride which separates is fused with common salt and is electrolyzed.

Interesting and instructive accounts of aluminum alloys, aluminum solder, and the production of aluminum salts may be seen in Part I of the Mineral Resources of the United States for 1915, by W. C. Phalen of the U. S. Geological Survey.

CEMENT.

EUGENE A. SMITH.
E. F. BURCHARD.

DURING the past seven years only one establishment in Alabama has been engaged in the manufacture of slag cement, using the material from the furnaces about Birmingham. The production is included in the returns for Portland cement and cannot be given separately.

PORTLAND CEMENT.

RESOURCES.

Alabama contains large supplies of limestone, chalk, clay and shale well adapted to Portland Cement manufacture, and widely distributed throughout the State. Coal and labor are abundant and cheap, transportation facilities are excellent, and many of the best limestone and chalk localities are situated on navigable rivers, giving ready access and cheap water transportation to Galveston, New Orleans, Mobile, Charleston, and other ports of the Gulf and Atlantic Coasts. This advantage of location was immensely increased with the opening of the Panama Canal for cement plants located in Alabama are more than a thousand miles nearer to the Isthmus than their nearest possible competitors.

The limestones and shales of the northern part of the State lie so close to each other, and above all so close to the great

coal mines which must supply the fuel, that the establishment of Portland Cement plants near the coal mines would give to this industry in Alabama the same advantages which the proximity of the iron ore, the coal, and the stone has given to the iron industry, and which has placed our State beyond competition.

As a Portland cement mixture, ready for burning, consists approximately of 75 per cent lime carbonate and 25 per cent of clayey matter, the material furnishing the lime carbonate is necessarily of more economic importance than that from which the silica and alumina are derived. In consequence, a Portland cement plant is usually located in the immediate vicinity of a suitable limestone, while the clay or shale required to complete the mixture may be brought some distance.

The limestone formations in North Alabama which can supply the stone adapted for use in cement manufacture are the Trenton or Pelham limestone and the Bangor or Subcarboniferous. In close proximity to both these limestone formations are the shales of the Clinton, Subcarboniferous and Coal Measures.

At the present time there are two cement plants in North Alabama, namely, the Standard Portland Cement Co., located at Leeds in Jefferson County, and the Coosa Portland Cement Co., located at Ragland in St. Clair County. Both of these plants make use of the hard Trenton limestone, and the Standard Cement Co., according to Burchard of the U. S. Geological Survey, uses the shale of the Clinton formation whilst the Ragland Company makes use of the shales of the Coal Measures. Up to the present time no establishment is utilizing the Bangor limestone.

In Middle Alabama the soft, chalky Cretaceous limestone of the Selma Chalk, is the material utilized by the Alabama Portland Cement Co., at Spocari, near Demopolis. The same Company makes use of residual clays overlying and derived from the weathering of the Selma Chalk. During 1915 there was no production from the Demopolis plant.

In Southern Alabama the St. Stephens limestone outcropping east and west across the State, furnishes excellent material for Portland Cement manufacture, using either residual clays from decomposition of the limestone, or the clays of the Grand

Gulf formation which are almost everywhere in close proximity to the limestone.*

Puzzolan Cement.

Puzzolan or slag-lime cement was shipped during 1915 from plants at North Birmingham, Ala., Struthers, Ohio, and Sharon, Pa. The output in 1915 was 42,678 barrels, valued at $39,801, compared with 68,311 barrels, valued at $63,358, in 1914. This represents a decrease in quantity of 25,633 barrels, or nearly 38 per cent and in value of $23,557, or more than 37 per cent. The average price per barrel of Puzzolan cement in 1915 was about 93.3 cents, compared with 92.6 cents in 1914, an increase of 0.7 cent a barrel. The price of this cement, therefore, increased slightly in 1915, and was 7.3 cents higher than that of Portland cement. Puzzolan cement should command a good average price, for a considerable proportion of it is of light color, and nonstaining properties are claimed for it by the manufacturers.

The following table summarizes the number of active plants and the production of puzzolan cement produced during the last five years. Since 1912, inclusive, the quantities represent marketed production or shipments.

Statistics of the puzzolan cement industry, 1911-1915.

	1911	1912	1913	1914	1915
Number of plants reporting production:					
Alabama	1	1	1	1	1
New York†	1	1	1	1	.....
Ohio	1	1	1	1	1
Pennsylvania	1	1	1	1	1
	4	4	4	4	3
Production in barrels	93,230	91,864	107,313	68,311	42,678
Total value	$77,786	$77,363	$97,663	$63,358	$39,801

†Includes production of Collos cement, 1911-1914.

*Since recent investigations (quoted by Burchard), have shown that limestones containing as much as 10 per cent of magnesia, (MgO), may be used in the manufacture of Portland cement, without detriment to the quality of the cement, the quantity of limestone in Alabama suitable for this manufacture is very greatly increased, over former estimates.—E. A. S.

Owing to the fact that there was in Alabama in 1915 only one producer of puzzolan cement, and not more than two operating plants in the Portland cement industry, it is necessary to combine the productions of the two industries in order to avoid publishing figures which were given to the survey in confidence. The tabular results of such a combination are, however, necessarily inconsistent and not to be taken too literally, since the weights per barrel of the two kinds of cement vary.

The total quantity of Portland and puzzolan cement shipped to market in Alabama in 1915, was 1,114,386 barrels, valued at $891,473, as compared with 777,698 barrels in 1914, valued at $746,555, or an increase in quantity of 336,788 barrels or 43.31 per cent, and an increase in value of $144,918 or 19.41 per cent.

Below are presented in tabular form the foregoing figures:

Quantity and value of portland and puzzolan cement marketed in Alabama in 1914 and 1915.

	No. of Producers	Quantity (Bbls.)	Value.
1914	3	777,698	$746,555
1915	3	1,114,386	891,473
Increase		366,788	144,918
Per cent of Increase		43.31	19.41

In "Mineral Resources of the United States, for 1915. Part II, (pages 189-212)," the reader, who is interested in the subject, will find a very complete presentation of the cement industries of the United States, by Mr. E. F. Burchard of the U. S. Geological Survey.

Recovery of Potash From Portland Cement Materials.

The collection or elimination of dust in the cement plant is one of the most important problems in cement manufacture at present, and incidental to the study of this problem the year 1915 witnessed an awakening of interest on the part of several cement companies to the possibility of recovering potash as a by-product in cement manufacture. The pioneer in this field was the Riverside Portland Cement Co., the plant of which is at

Riverside, Cal. The operations at this plant have been mentioned by W. C. Phalen in recent chapters of Mineral Resources on potash salts. The early efforts of the Riverside company, which employs the Cottrell electrical precipitation process,[1] were directed rather toward precipitating waste dust than toward recovering potash, but the company soon discovered that, although the raw mix contained only about 0.2 per cent of potash, the dust contained potash in considerable quantities and a large portion of it is now being recovered. Since the supply of potash from Germany has been cut off the Riverside company has contracted for the sale of its potash at prices that yielded large returns on the investment for the dust-collecting equipment. The Western Precipitation Co., of Los Angeles, Cal., controls the license for all applications of the Cottrell precipitation process to cement manufacture.

The abnormally high prices for potash that have prevailed since the shortage began to be felt have, of course, stimulated many and diverse efforts to discover or devise a domestic source of potash, and the first plant in the East to follow the lead of the Riverside plant is that of the Security Cement & Lime Co., at Security, near Hagerstown, Md., where in May, 1916, the company's potash-recovery plant was rapidly nearing completion.

CLAY AND CLAY PRODUCTS.

CLAY.

JEFFERSON MIDDLETON AND EUGENE A. SMITH.

CLAY available for the manufacture of clay products is one of the most widely distributed of our minerals. Hence there are clay-working plants scattered over every State and Territory in the Union. Miners of the low-grade clays are usually also the manufacturers, but as the higher grades of ware are reached, the rule is that fewer and fewer manufacturers are also miners, until in the highest grades of ware the

1 For details of this process see Schmidt, W. A., Cottrell processes of electrical precipitation: Canadian Min. Inst. Trans., vol. 18, pp. 110-113, 1915.

rule is that the manufacturer buys and does not mine the clay he uses. The figures given in the following tables represent clay that is mined and not manufactured by the miner, but is sold as clay. The clay thus sold is small in quantity compared with the total production and includes mainly clay used for high-grade pottery and tile, for paper making, and for refractory products.

The total amount of clay mined in Alabama and sold as such in 1915 was 31,870 short tons, valued at $35,232. This was an increase in quantity of 3,897 tons, or 13.93 per cent, and of $625, or 1.81 per cent in value as compared with 1914.

Below is a table giving the production and value of clay mined and sold in Alabama from 1908 to 1915 inclusive, and a comparison of the production of 1914 and 1915:

Production of clay in Alabama from 1908 to 1915 inclusive, and a comparison of the production in 1914 and 1915.

YEAR	Fire Clay		Miscellaneous Clay.		Total.	
	Quantity Short Tons	Value.	Quantity Short Tons	Value.	Quantity Short Tons	Value.
1908	68,289	$48,983	24,000	$12,000	92,289	$60,983
1909	45,137	35,345	18,271	5,587	63,408	40,932
1910	54,482	32,395	20,600	5,650	75,082	38,045
1911	35,203	29,909	.....	.....	35,203	29,909
1912	38,552	31,414	4,500	2,000	43,052	33,414
1913	49,901	53,269	*	*	49,901	53,419
1914	27,973	34,607	.....	.....	27,973	34,607
1915	31,520	34,882	*	*	31,870	35,232
Increase	3,547	275	.....	.....	3,897	625
Percentage	12.68	0.79	.....	.....	13.93	1.81

In 1914 the average value of Alabama fire clay was $1.23 per short ton, and the value of the Alabama product was 1.61† per cent of the total value of the fire clay produced in the United States. In 1915 the average value of the fire clay of Alabama was $1.11 per short ton, and the value of fire clay production of the State was 1.48 per cent of the total value of the United States production.

*Not divulged but included in total.

†This was by mistake given at 0.92 in the 1914 Statistical Report.—E. A. S.

Clay Products.

The clay products of Alabama in 1915 were valued at $1,193,022—brick and tile, $1,177,725; pottery, $15,297—a decrease of $381,001. Its principal clay product was common brick, valued at $382,092, or 32 per cent of the State total, a decrease of $256,754 from 1914. The quantity of common brick reported for 1915 was 70,681,000 brick, a decrease of 40,050,000 brick. Common brick was closely followed by vitrified brick or block, valued at $374,387, an increase of $125,862. The quantity of vitrified brick marketed in 1915 was 29,018,000 brick, an increase of 10,339,000 brick or block, Alabama ranked twenty-fourth in 1915 among the States in value of clay products, and 65 operators reported sales.

Jefferson County was the principal clay-working county, and reported a production valued at $815,338, or 68 per cent of the State's total value in 1915, a decrease of $213,797. Nearly all of the fire brick produced in the State comes from Jefferson County. Jefferson County is also the only producer of vitrified brick or block. The principal producing counties of common brick, named in the order of the value of output, were: Jefferson, Montgomery, Russell, and Talladega.

Clay products of Alabama, 1910-1915.

Product.	1910	1911	1912	1913	1914	1915
Brick:						
Common—						
Quantity	135,785,000	129,694,000	136,989,000	130,923,000	110,731,000	70,681,000
Value	$746,961	$708,903	$759,409	$730,148	$638,666	$382,092
Average per M	$5.50	$5.47	$5.54	$5.58	$5.77	$5 41
Vitrified—						
Quantity	19,772,000	21,444,000	26,480,000	24,183,000	18,679,000	29,018,000
Value	$236,516	$246,707	$353,303	$361,722	$248,525	$374,387
Average per M	$11.96	$11.50	$13.34	$14.96	$13.31	$12.90
Front—						
Quantity	(*)	9,169,000	10,629,000	(*)	(*)	5,815,000
Value	(*)	$128,403	$132,033	(*)	(*)	$58,212
Average per M	$15.96	$14.00	$12.42	$15.29	$11.42	$10.01
Fancy, value	.....	(*)	(*)	.....	(*)	.....
Fire, value	$163,672	$193,375	$240,434	(*)	$167,021	$145,535
Draintile, value	$3,773	$3,777	$5,465	$10,802	$6,838	$9,330
Sewer pipe, value	(*)	(*)	(*)	(*)	(*)	(*)
Fireproofing, value	(*)	(*)	(*)	(*)	(*)	$62,114
Tile, not drain, value	.....	.....	.....	(*)	.....	.....
Pottery:						
Red earthenware, value	$3,475	$11,243	$10,990	$11,164	$4,800	$6,741
Stoneware and yellow and Rockingham ware, value	$16,371	$14,753	$11,223	$8,994	$11,742	$8,556
Miscellaneous, value	$496,791	$639,941	$422,322	$968,751	$496,431	$146,055
Total value	$1,667,559	$1,947,102	$1,935,179	$2,091,581	$1,574,023	$1,193,022
Number of active firms reporting	87	82	74	68	70	65
Rank of State	22	17	17	16	20	24

*Included in "Miscellaneous."

Brick and Tile.

The total production of common brick in Alabama in 1915 was 70,681 M, valued at $382,092. This as compared with the 1914 production was a decrease of 40,040 M, or 36.16 per cent, and a decrease in value of $256,574 or 40.18 per cent.

In the case of vitrified brick there was an increase of 10,339 M, in quantity, or 55.35 per cent, and an increase in value of $125,862 or 50.64 per cent.

There was a decrease in the quantity of fire brick of 1,391 M, or 15.95 per cent, and in the value of $21,486 or 12.86 per cent.

The following tables give a review of the brick and tile industry of Alabama for the years 1914 and 1915:

Production of brick and tile in Alabama in 1915, not including pottery products.

Kinds.	Quantity Thousands	Value.	Av. price per M.	Per Cent of Total Value of Brick and Tile	Per Cent of Total U. S. Value.
Common brick	70,681	$382,092	$5.41	32.44	.91
Vitrified brick	29,018	374,387	12.90	31.79	3.06
Front brick	5,815	58,212	10.01	4.94	.61
Drain tile	.....	9,330	.....	.79	.15
Fire proofing	.....	62,114	.....	5.27	.81
Fire brick	7,330	145,535	19.85	12.36	.77
Miscellaneous	.....	*146,055	.....	12.40	3.93
Total	.....	$1,177,725	.....	100.00	0.94

*Includes sewer pipe, stove lining, silica brick, etc.

Brick and tile production in 1914 and 1915 compared.

Kind.	1914			1915			Increase or Decrease in Value.	Percentage.
	Quantity M	Value.	Average Price.	Quantity M	Value.	Average Price.		
Common brick	110,731	$638,666	$ 5.77	70,681	$382,092	$ 5.41	—256,574	40.18
Vitrified brick	18,679	248,525	13.31	29,018	374,387	12.90	+125,862	50.64
Front brick	*	*	*11.42	5,815	58,212	10.01	.....	.....
Drain tile	.....	6,838	.....	.....	9,330	.....	+ 2,492	36.40
Fire proofing	.....	.....	.....	.....	62,114	.....	.....	.....
Fire brick	8,721	167,021	19.15	7,330	145,535	19.85	— 21,486	12.86
Miscellaneous	.....	†496,431	.....	.....	†146,055	.....	.....	.....

*Included in Miscellaneous. †Sewer pipe, stove lining, silica brick, etc.

POTTERIES.

The pottery industry of Alabama is of relatively small importance, as only the commoner and coarser grades of ware are produced and most of this for local trade only.

Production was reported in 1915 by 13 firms; the same as in 1914. The output was valued at $15,297, a decrease of $1,245 or 7.53 per cent. The products consisted of red earthen ware and stone ware only. The rank of Alabama in this industry for 1915, as for 1914, was 19.

Value of pottery products in 1915.

Kind.	Value.	Percentage of Total Alabama Pottery Products.	Percentage of Total U.S. Value.
Red earthenware	$6,741	44.06	0.63
Stoneware and Rockingham ware	8,556	55.94	0.37
Total	$15,297	100.00	.04

Comparison of pottery products in 1914 and 1915.

Kind.	1914	1915	Increase+ or Decrease—	Percentage.
Red Earthenware	$ 4,800	$ 6,741	+$1,941	40.44
Stoneware and Rockingham ware	11,742	8,556	— 3,186	27.13
Total	$16,542	$15,297	—$1,245	7.53

COAL.

E. W. Parker and C. E. Lesher.

Introductory.

THE great Appalachian coal region which furnishes over two-thirds of the coal production of the United States and which extends from Ohio and Pennsylvania on the north in a gradually narrowing belt through eastern Kentucky and Tennessee has its southern terminus in a considerably broadened area that occupies a large part of the northern half of Alabama. The coal-bearing formations of Alabama underlie about 8,400 square miles and are divided into four distinct basins, the Coosa, the Cahaba, and the Warrior, named from the rivers which drain them, and the Plateau, which includes Blount, Lookout, and Sand or Raccoon Mountains. By far the most important basin in area and in production is the Warrior, which includes all of Walker County, most of Jefferson, Tuscaloosa, and Fayette counties, and smaller parts of Blount, Cullman, Winston and Marion counties. The area known to contain coal is approximately 4,000 square miles, or one-half the total coal area of the State, and contributes about 81 per cent of the total production.

There are several distinct coal groups in the basin, the most important of which are the Brookwood, the Pratt, and the Mary Lee, designated by the names of their principal beds. The Mary Lee group includes the Blue Creek, the Jagger, and the Newcastle beds, most of which are mined in places. The Brookwood, the Pratt, and the Mary Lee produce most of the coking coal mined in the State, and more than half of all of the coal mined in the district.

The Cahaba Basin, second in importance, is a long narrow syncline, 68 miles long and about 6 miles wide, southeast of the Warrior, and occupies parts of St. Clair, Jefferson, Shelby, and Bibb counties. There are many workable beds, and the total quantity of coal in the basin is large. The production is something over 18 per cent of the total for the State.

The Coosa Basin is a deep syncline east of the Cahaba and parallel with it, extending across Shelby and St. Clair counties. It is also long and narrow, 60 miles long by 6 miles wide. It has not been thoroughly explored, but in different parts of the area from two to twelve beds, 3 or more feet in thickness, have been reported.

The Plateau field embraces parts of Blount, Etowah, DeKalb, Cherokee, Marshall, and Jackson counties, and although it has an area underlain by coal four times that of the Cahaba and the Coosa combined, the resources in Alabama are comparatively small. There are four to six beds locally workable. So far as known, the earliest record of the existence of coal in Alabama was made in 1834. The first statement of production in the State is contained in the United States census report for 1840, in which year the production is given as 946 tons. The census report for 1850 does not mention any coal production for the State, and the next authentic record is contained in the census statistics of 1860, when Alabama is credited with an output of 10,200 short tons. The mines of Alabama were probably worked to a considerable extent during the Civil War, but there are no records of the actual production until 1870, for which year the United States census reports a production of 11,000 tons. Ten years later the production had increased to 323,972 short tons, but the development of the present great industry really began in 1881 and 1882, when attention was directed to the large iron deposits near the city of Birmingham and thus the great "boom" of that city and vicinity was inaugurated. By 1885 the coal production of the State had increased to nearly 2,500,000 tons. Then followed a period of relapse and liquidation, which lasted two years, after which business settled down to a conservative and rational basis and has since developed steadily. In 1902 the coal production of the State reached a total of more than 10,000,000 tons, and reached the maximum of 17,678,522 tons in 1913, since which time there has been a decrease.

PRODUCTION.

Total production in 1915, 14,927,937 net tons; spot value, $19,066,043. This represents a decrease of 665,485 tons, or 4 per cent, in quantity and of $1,783,876, or 9 per cent, in value

compared with 1914. During the early part of the year many of the Alabama operators, less hopeful than the others, contracted for the sale of their output at lower prices than previously, with the result that the average value for the year decreased from $1.34 per ton in 1914 to $1.28 in 1915. The number of men employed decreased from 24,042 in 1914 to 22,591 in 1915 and the average number of days worked per man from 226 to 223. There was, however, no shortage of labor during the year.

The demand for Alabama coal was very light during the first half of 1915 and many mines were shut down. In August, however, marked industrial activity began, and the general resumption of operations by practically all the Alabama iron furnaces was a large factor in increasing the rate of production of coal toward the end of the year. Railroad and industrial activities were nevertheless below normal throughout the year, and the total output of coal was less than in any other period since 1909. In ordinary times Alabama supplies a large quantity of coal for steamship bunkers at Pensacola, Mobile, Gulfport, and New Orleans; but since the European war began there has been little call for coal for that purpose at those ports. The development of water power on a large scale in Alabama has also cut off the market for a large quantity of coal. The opening of Warrior River to navigation was expected to offer an outlet for large quantities of coal to New Orleans and Mobile ports, but in 1915 there was no demand from those sources and a comparatively small quantity of Alabama coal found markets over that waterway.

The statistics of the production of coal in Alabama in 1914 and 1915 are shown in the following tables:

Coal produced in Alabama in 1914 and 1915 (by counties).

1914

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Bibb	1,565,660	9,180	100,006	.....	1,674,846	$ 2,576,057	$1.54	2,986	242
Blount	147,640	1,300	1,444	.....	150,384	188,235	1.25	348	163
Etowah	153,402	1,293	2,214	.....	156,909	222,239	1.42	279	241
Jefferson	6,515,079	46,527	292,071	1,082,468	7,936,145	10,486,552	1.32	11,343	236
St. Clair	726,132	1,816	24,640	.....	752,588	978,196	1.30	896	229
Shelby	467,456	3,916	27,542	.....	498,914	927,442	1.86	936	239
Tuscaloosa	428,387	13,355	59,562	357,595	858,899	1,177,473	1.37	1,491	226
Walker	3,037,567	51,284	112,704	248,630	3,450,185	4,124,363	1.20	5,416	199
Winston	31,035	525	58	.....	31,618	46,787	1.48	101	248
Other counties*	73,496	1,704	5,841	.....	81,041	119,496	1.47	246	187
Small mines	.....	1,893	.....	.....	1,893	3,079	1.63	.....	.....
	13,145,854	132,793	626,082	1,688,693	15,593,422	$20,849,919	$1.34	24,042	226

*Cullman, Jackson, and Marion counties.

1915

Bibb	1,420,639	8,359	105,536	.....	1,534,534	$2,093,131	$1.36	2,623	235
Blount	163,018	1,021	1,700	.....	165,739	226,716	1.37	368	189
Etowah	173,583	1,974	1,811	.....	177,368	259,332	1.46	325	289
Jefferson	5,884,992	329,456	197,806	1,167,249	7,579,503	9,658,836	1.27	10,129	235
Marion	62,653	1,275	4,962	.....	68,890	101,318	1.47	199	163
St. Clair	754,569	2,959	16,530	.....	774,058	946,446	1.22	786	252
Shelby	550,594	3,290	35,528	.....	589,412	989,580	1.68	1,058	227
Tuscaloosa	298,627	9,545	71,277	408,137	787,586	963,910	1.22	1,334	209
Walker	2,886,594	29,925	99,950	205,486	3,221,955	3,784,424	1.17	5,669	197
Winston	26,217	370	40	.....	26,627	38,919	1.46	80	191
Small mines*	1,000	1,065	200	.....	2,265	3,431	1.51	20	12
	12,222,486	389,239	535,340	1,780,872	14,927,937	$19,066,043	1.28	22,591	223

*Includes Jackson county.

In the following table comparative statistics are given covering five years' annual production of coal in Alabama, by counties. The three counties of largest production, Bibb, Jefferson, and Walker, were all below the average for the 5-year period. In fact, both Bibb and Jefferson in 1915 had the lowest output in five years. Shelby County has shown consistent gains each year, and 4 counties out of 11 recorded increase in 1915.

Coal produced in Alabama, 1911-1915, in net tons (by counties).

County.	1911	1912	1913	1914	1915	Increase or decrease, 1915.
Bibb	1,633,197	1,781,335	1,911,026	1,674,846	1,534,534	— 140,312
Blount	82,266	146,342	178,958	150,384	165,739	+ 15,355
Cullman, Jackson, and Marion	(*)	131,505	123,615	81,041	†70,290	— 10,751
Etowah	255,860	171,308	137,792	156,909	177,368	+ 20,459
Jefferson	7,776,390	8,174,849	9,028,834	7,936,145	7,579,503	— 356,642
St. Clair	529,211	749,753	890,379	752,588	774,058	+ 21,470
Shelby	463,089	496,949	497,569	498,914	589,412	+ 90,498
Tuscaloosa	1,031,658	880,967	917,305	858,899	787,586	— 71,313
Walker	3,103,595	3,547,962	3,967,263	3,450,185	3,221,955	— 228,230
Winston	16,424	18,730	24,951	31,618	26,627	— 4,991
Small mines	*129,731	900	830	1,893	865	— 1,028
Total	15,021,421	16,100,600	17,678,522	15,593,422	14,927,937	— 665,485
Total value	$19,079,949	$20,829,252	$23,083,724	$20,849,919	$19,066,043	— $1,783,876

*Small mines include Cullman, Jackson, and Marion counties.
†No production in Cullman county.

The statistics of production in Alabama from 1840 to the close of 1915 are shown in the following table:

Production of coal in Alabama from 1840 to 1915 in short tons.

Year	Quantity	Year	Quantity	Year	Quantity	Year	Quantity
1840	946	1860	10,200	1880	323,972	1900	8,394,275
1841	1,000	1861	10,000	1881	420,000	1901	9,099,052
1842	1,000	1862	12,500	1882	896,000	1902	10,354,570
1843	1,200	1863	15,000	1883	1,568,000	1903	11,654,324
1844	1,200	1864	15,000	1884	2,240,000	1904	11,262,046
1845	1,500	1865	12,000	1885	2,492,000	1905	11,866,069
1846	1,500	1866	12,000	1886	1,800,000	1906	13,107,963
1847	2,000	1867	10,000	1887	1,950,000	1907	14,250,454
1848	2,000	1868	10,000	1888	2,900,000	1908	11,604,593
1849	2,500	1869	10,000	1889	3,572,983	1909	13,703,450
1850	2,500	1870	11,000	1890	4,090,409	1910	16,111,462
1851	3,000	1871	15,000	1891	4,759,781	1911	15,021,421
1852	3,000	1872	16,800	1892	5,529,312	1912	16,100,600
1853	4,000	1873	44,800	1893	5,136,935	1913	17,678,522
1854	4,500	1874	50,400	1894	4,397,178	1914	15,593,422
1855	6,000	1875	67,200	1895	5,693,775	1915	14,927,937
1856	6,800	1876	112,000	1896	5,748,697		
1857	8,000	1877	196,000	1897	5,893,770	Total	285,475,717
1858	8,500	1878	224,000	1898	6,535,283		
1859	9,000	1879	280,000	1899	7,593,416		

Coal produced in Alabama 1911-1915, and decrease in 1915.

Year	Quantity (net tons)	Value
1911	15,021,421	$19,079,949
1912	16,100,600	20,829,252
1913	17,678,522	23,083,724
1914	15,593,422	20,849,919
1915	14,927,937	19,066,043
Decrease, 1915	665,485	1,783,876
Percentage of decrease 1915	4.3	8.6

Rank of Coal Producing States.

The following tables give other details concerning the coal production in Alabama, including rank of the first ten coal producing states; labor statistics; strikes and suspensions; machines used; methods of mining, etc.:

Rank of first ten coal-producing States in 1914 and 1915, with quantity and value of products and percentage of each.

1914

Production				Value			
Rank	State or Territory	Quantity (short tons)	Percentage of total product'n	Rank	State or Territory	Value	Percentage of total value
1	Pennsylvania:			1	Pennsylvania:		
	Anthracite	90,821,507	17.7		Anthracite	$188,181,399	27.6
	Bituminous	147,983,294	28.8		Bituminous	159,006,296	23.3
2	West Virginia	71,707,626	14.0	2	West Virginia	71,391,408	10.5
3	Illinois	57,589,197	11.2	3	Illinois	64,693,529	9.5
4	Kentucky	20,382,763	4.0	4	Ohio	21,250,642	3.1
5	Ohio	18,843,115	4.0	5	Kentucky	20,852,463	3.0
6	Indiana	16,641,132	3.2	6	Alabama	20,849,919	3.0
7	Alabama	15,593,422	3.0	7	Indiana	18,290,928	2.7
8	Colorado	8,170,559	1.6	8	Colorado	13,601,718	2.0
9	Virginia	7,959,535	1.5	9	Iowa	13,364,070	2.0
10	Iowa	7,451,022	1.4	10	Kansas	11,238,253	1.6

1915

1	Pennsylvania:			1	Pennsylvania:		
	Anthracite	88,995,061	16.8		Anthracite	$184,653,498	26.9
	Bituminous	157,955,137	29.7		Bituminous	167,419,705	24.4
2	West Virginia	77,184,069	14.5	2	West Virginia	74,561,349	10.8
3	Illinois	58,829,576	11.1	3	Illinois	64,622,471	9.4
4	Ohio	22,434,691	4.2	4	Ohio	24,207,075	3.5
5	Kentucky	21,361,674	4.0	5	Kentucky	21,494,008	3.1
6	Indiana	17,006,152	3.2	6	Alabama	19,066,043	2.8
7	Alabama	14,927,937	2.8	7	Indiana	18,637,476	2.7
8	Colorado	8,624,980	1.6	8	Colorado	13,599,264	2.0
9	Virginia	8,122,596	1.5	9	Iowa	13,577,608	2.0
10	Iowa	7,614,143	1.4	10	Kansas	11,360,630	1.6

LABOR STATISTICS.

Statistics of labor employed in coal mines of Alabama 1908-1915.

Year	Number of days active	Average Number Employed
1908	222	19,197
1910	249	22,210
1911	227	22,707
1912	245	22,613
1913	255	24,552
1914	226	24,042
1915	223	22,591

Average production per man compared with hours worked per day, and average number of days worked 1910-1915.

Year	8 hours		9 hours		10 hours		All others	Total	Days Worked	Average Tonnage	
	Mines	Men	Mines	Men	Mines	Men	Men	Men		Per Year	Per Day
1910	18	766	36	2,633	134	17,306	1,525	22,230	249	725	2.91
1911	15	550	50	5,345	102	12,628	4,184	22,707	227	662	2.92
1912	11	338	46	4,145	107	13,938	4,192	22,613	245	712	2.91
1913	13	420	36	2,496	135	18,185	3,451	24,552	255	720	2.82
1914	14	646	24	3,546	150	18,115	1,735	24,042	226	648	2.87
1915	13	369	44	4,402	133	17,109	711	22,591	223	661	2.96

Statistics of labor strikes in the coal mines of Alabama in 1914 and 1915.

1914			1915		
Number of men on strike	Total days lost	Average number of days lost per man	Number of Men on strike	Total days lost	Average number of days lost per man
320	3,940	12	175	1,290	7

COAL MINED BY MACHINES IN ALABAMA.

Bituminous coal mined by machines in Alabama in 1914 and 1915.

Year	Number of machines in use	Number of tons mined by machines	Total tonnage of Alabama	Percentage of total product mined by machines
1914	362	4,937,222	15,593,422	31.7
1915	373	5,285,133	14,927,937	35.4

Quantity and percentage of coal mined by different methods in Alabama in 1914 and 1915, short tons.

Year	Mined by hand	Percentage	Shot off the solid	Percentage	Mined by machines	Percentage	Not reported	Percentage	Total production
1914	5,134,787	32.9	5,498,988	35.3	4,937,222	31.7	22,425	.14	15,593,422
1915	4,634,815	31.0	5,001,653	33.5	5,285,133	35.4	6,336	.04	14,927,937

COAL WASHING OPERATIONS.

Coal washed at the mines in Alabama in 1914 and 1915, with quantity of washed coal and of refuse obtained from it, short tons.

Year	Quantity of coal washed	Quantity of cleaned coal	Quantity of refuse
1914	7,913,030	7,081,868	831,162
1915	8,734,475	7,920,122	814,353

AVERAGE VALUE OF ALABAMA COAL.

Average value per short ton for coal at the mines in Alabama since 1908.

1908	1909	1910	1911	1912	1913	1914	1915	Decline in 1915
$1.26	$1.19	$1.26	$1.27	$1.29	$1.31	$1.34	$1.28	$0.06

DISTRIBUTION AND CONSUMPTION.

C. E. LESHER.

OBJECT AND SCOPE OF REPORT.

THE object of this report is to furnish statistics showing the internal distribution of the coal produced in the United States, the principal purposes for which it is used, and the quantities consumed in each State. For 34 years the Geological Survey has collected and published the statistics of the production and value of coal, but this is the first comprehensive investigation made to show in detail where the coal produced is consumed. The competition between the bituminous coal-producing districts in the United States for the domestic markets is as active as that between the coal-exporting nations of the world for the foreign markets. The extent and nature of the demand in the domestic markets are moreover of ever-present interest to our coal industry, because more than 95 per cent of the coal produced in the United States is used within the country.

The largest problem confronting the exploiters of a coal deposit is, of course, that of markets, and whoever produces or sells the coal must consider in a broad way the possible markets not only as to quantity but as to quality. For blacksmithing and for making coal gas, coals that have special chemical properties are required, and domestic users have established preferences based on both experience and prejudice. By far the largest part of the coal supplied to every market is used for raising steam, and the statistics of coal used for this purpose in any and every part of the country are therefore of primary interest to those who are engaged in the coal industry. The limitations of time and funds available for the work on this report have permitted only incidental consideration of the markets for bituminous coals of particular kinds. The distribution of coal from West Virginia, for instance, is shown for the State as a unit, though there is a great difference between the kinds of coal mined there and as great a difference between the markets reached by the coal.

The cost of mining, the largest element of which—the cost of labor—is now practically controlled either directly or indirectly by the labor unions, and the cost of transportation, regulated by the Government through the Interstate Commerce Commission, impose definite limitations upon the markets that may profitably be reached by any coal. It is fast becoming the rule that the deciding factor in the purchase of coal for most uses is its cost in terms of the work to be performed.

Statistics of the movement of coal to market are of particular interest to those who are considering railroad rates. The quantity of coal carried by the railroads is larger than that of any other single commodity, and it is the coal traffic that has made possible the profitable operation of a number of important railroads. It is to the interest of the coal-carrying roads, within the limits of fair play, to keep in balance the movement from the competing fields. Here, again, data of the kind given in this report are needed as a basis of intelligent action.

DISTRIBUTION OF COAL PRODUCED IN ALABAMA IN 1915.

IN ITS output of coal Alabama is the most productive State in the South, and it is centrally located as regards the markets of the Southern States. In 1915 the southern railroads used nearly 5,000,000 tons of Alabama coal, which is 32 per cent of the production in Alabama and nearly 23 per cent of the consumption by the railroads in the South. About 200,000 tons of coal from Alabama was used by railroads west of Mississippi River. In addition to that taken by the railroads, more than 7,300,000 tons, or nearly half the total output, was used in the State; 2,000,000 tons, or 13.5 per cent of the output, was shipped to other States; and 500,000 tons, or 3.5 per cent, went to tidewater for foreign and domestic cargo and bunker fuel. Of the coal shipped outside the State for commercial use the greater part, about 1,500,000 tons, reached the Mississippi Valley markets in Louisiana and Mississippi and in a less amount those in Missouri, Tennessee, and Arkansas. On

the east, Georgia and Florida are the best consumers of Alabama coal.

Competition by coal from the fields to the north, particularly those of southern Illinois and western Kentucky, restricts the expansion of markets for coal from Alabama in the Mississippi Valley and at New Orleans. Similar competition on the east by coal from Virginia, Kentucky, and Tennessee meets coal from Alabama in the markets of the Carolinas and Georgia. The higher grades of Alabama coal are sent in small shipments to markets as distant as the Pacific coast. The tidewater business at southern Atlantic ports (except Hampton Roads) and at gulf ports is not very large as compared with that at the northern ports, and in 1915 it was below normal. About 500,000 tons of coal from Alabama reached tidewater in 1915.

Coal shipped to tidewater points from Alabama in 1915, in net tons.

Port.	Quantity	Use.	Quantity
Mobile, Ala.	103,320	Foreign export	23,641
Pensacola, Fla.	145,369	Foreign bunker	319,307
New Orleans, La.	116,205	Domestic bunker	160,951
South Carolina ports	11,904		
Georgia ports	127,101		
	503,899		503,899

Distribution of coal mined in Alabama in 1915.

	Quantity (net tons)	Percentage of total
Used in Alabama		
Used at mines for steam and heat	535,340	
Sold to local trade, not shipped	289,239	
Made into coke at mines	1,780,872	
Shipped to Alabama points	4,742,435	
Total used in Alabama	7,347,886	49
Shipped to other States:		
Arkansas	10,450	
California	292	
Florida	108,782	

Distribution of coal mined in Alabama in 1915.—Continued.

	Quantity (Net tons).	Percentage of total.
Georgia	363,572	
Louisiana	717,437	
Mississippi	596,218	
Missouri	3,519	
North Carolina and South Carolina	475	
Oklahoma	713	
Oregon	190	
Tennessee	161,754	
Texas	39,987	
Virginia	307	
Washington	21	
Total shipped to other States (all rail)	2,003,717	14
Shipped to tidewater	503,899	3
Used by railroads:		
Loaded at mine tipples	100,000	
Shipped	4,972,435	
Total used by railroads	5,072,435	34
Total production	14,927,937	100

Shipments of bituminous coal in Alabama, by railroads and waterways, in 1915.

Route	Quantity net tons
Railroad	
Alabama Great Southern	51,507
Atlanta, Birmingham and Atlantic	180,859
Birmingham Southern	2,390,482
Central of Georgia, Alabama and Georgia	788,716
Frisco (includes Alabama Central, Birmingham Belt, and B. R. L. & P. (Huntingdon)	1,793,672
Illinois Central	95,553
Louisville & Nashville (includes Warrior Mineral)	3,229,139
Mobile and Ohio	309,162
Nashville, Chattanooga & St. Louis, Alabama and Tennessee coal combined	1,068,870
Southern (includes Northern Alabama)	2,895,131
Seaboard Air Line, Thomas & Sayreton	380,255
Waterway—Warrior River	169,618

Consumption of coal produced in 1915, by uses.

Uses	Quantity (net tons)	Percentage of total Ala. Production
Railroad fuel	5,072,435	34.0
Steamship bunker fuel, tidewater	480,258	3.2
Manufacture of bee-hive coke	1,708,228	11.4
Manufacture of by-product coke	2,987,710	20.0
Manufacture of coal gas	109,160	.8
Domestic and small steam trade	1,592,932	10.7
Industrial steam trade	2,389,397	16.1
Exported	23,641	.1
Used at mines for steam and heat	535,340	3.6
Special uses, blacksmithing mainly	28,836	.1
Total	14,927,937	100.0

Coal consumed in Alabama in 1915, according to source.

(Exclusive of fuel for railroads and steamships.)

Source	Quantity Net Tons
Alabama	7,347,886
Georgia	38
Kentucky	56,913
Tennessee	48,942
Virginia	67,961
West Virginia	2,800
Total bituminous coal	7,524,540
Pennsylvania anthracite	8,100
	7,532,640

COKE.

C. E. LESHER AND EUGENE A. SMITH.

INTRODUCTION.

THE production of coke in Alabama decreased from 3,084,149 short tons valued at $8,408,443 in 1914, to 3,071,811 tons valued at $8,545,555 in 1915. The decrease was 12,338 tons, or .4 per cent in quantity, and an increase of $137,112 or 1.6 per cent in value. There were in Alabama in 1915, 4 retort oven establishments with a total of 750 ovens, and these four establishments produced 2,070,334 tons or nearly 67 per cent of the total output, whereas 18 active beehive plants with an aggregate of 2,506 ovens in blast, produced 1,001,477 tons, or a little more than 33 per cent of the total. The average production per oven in the by-product plants was 2,760 tons and the average production from active beehive ovens was 300 tons. The increase in the production of by-product coke in 1915 over 1914 was 38,799 tons or 1.9 per cent, and the decrease in the production of beehive coke was 51,137 tons or 4.9 per cent. The value of the by-product coke, showed an increase of $380,000, or 7.5 per cent. The average yield of coal in coke from the retort ovens was 69.3 per cent, and the average yield in the beehive ovens was 58.6 per cent. There is not the marked difference in the values of retort and beehive cokes (and in favor of the former) in Alabama as is shown in some states, for in Alabama the retort ovens, like the beehive, are located near the mines, and the two in that respect are somewhat on a parity, whereas in most of the states in which retort coke is made the ovens are at a considerable distance from the mines, and the transportation charges assessed against the coal appear in the cost of the coke to the consumer. In fact, Alabama beehive coke had a higher value per ton in 1915 than the retort coke, the average being for the beehive $3.08 and for the retort coke, $2.64. The explanation of this seeming inconsistency lies in the fact that all of the retort coke is used by the producers in their own furnaces, and the coke is charged to the furnaces at little more than cost, whereas the greater part of the beehive product is commercial coke, some of it for foundry use, and profits are included in the value.

That the beehive has had its day in Alabama and is on the decline is evidenced by the fact that no new ovens of that type have been built in the last six years, and that 20 establishments with a complement of 4,734 ovens out of a total of 38 establishments with 8,568 ovens were idle in 1915 not counting the idle ovens at plants producing some coke in 1915.

The number of retort ovens increased from 620 in 1912 and 700 in 1913 to 750 in 1914 and 1915. The 750 completed ovens included 300 Semet-Solvay and 450 Koppers ovens. There were no new ovens under construction at the close of 1915.

Production and Consumption.

The production of coke in Alabama in 1880, 1890, 1900 and annually from 1910 to 1915 is shown in the following tables:

Statistics of the manufacture of coke in Alabama, 1880-1915.

Year	Establishments	Ovens		Coal used (short tons)	Yield of coal in coke (per cent)	Coke produced (short tons)	Total value of coke at ovens	Value of coke at ovens, per ton
		Built	Building					
1880	4	316	100	106,283	57.0	60,781	$ 183,063	$3.01
1890	20	4,805	371	1,809,964	59.0	1,072,942	2,589,447	2.41
1900	30	6,529	690	3,582,547	58.9	2,110,837	5,629,423	2.67
1910	43	10,132	340	5,272,322	61.6	3,249,027	9,165,821	2.82
1911	44	10,121	280	4,411,298	62.6	2,761,521	7,593,594	2.75
1912	46	10,208	100	4,585,498	64.9	2,975,489	8,098,412	2.72
1913	46	10,284	20	5,218,323	63.6	3,323,664	9,627,170	2.90
1914	38	*†9,318	0	4,678,196	65.9	3,084,149	8,408,443	2.73
1915	38	*9,318	0	4,695,938	65.4	3,071,811	8,545,555	2.78

*Includes 300 Semet-Solvay and 450 Koppers ovens.

†In 1914 Report the number of ovens was given at 9,285 on account of 33 ovens not being included in the total.

Comparison of the production and value of coke in Alabama in 1914 and 1915.

	Number of ovens	Coal charged (short tons)	Coke produced (short tons)	Total value of coke at ovens	Percentage of total U.S. value
1914	*9,318	4,678,196	3,084,149	$8,408,443	9.52
1915	9,318	4,695,938	3,071,811	8,545,555	8.10
Increase or decrease	+ 33	+ 17,742	— 12,338	+ 137,112	.....
Percentage	.3	.4	.4	1.6	.....

*The 1914 Bulletin gave this number as 9,285, due to an omission of 33 ovens.

Coke produced in beehive and by-product ovens in Alabama in 1914 and 1915.

Year	Beehive coke				By-product coke				Total		
	Active ovens	Coal used (net tons)	Coke produced (net tons)	Value of coke at ovens	Active ovens	Coal used (net tons)	Coke produced (net tons)	Value of coke at ovens	Coal used (net tons)	Coke produced (net tons)	Value of coke at ovens
1914	2,562	1,768,848	1,052,614	$3,329,606	750	2,909,348	2,031,535	$5,078,837	4,678,196	3,084,149	$ 8,408,443
1915	2,506	1,708,228	1,001,477	3,086,656	732	2,987,710	2,070,334	5,458,899	4,695,938	3,071,811	8,545,555
Increase or decrease	— 60	— 60,620	— 51,137	— 242,950	— 18	+ 78,362	+ 38,799	+ 380,062	+ 17,742	— 12,338	+ 137,112
Percentage	2.3	3.4	4.9	7.3	2.4	2.7	1.9	7.5	0.4	0.4	1.6

Coke consumed in Alabama in 1915, in net tons.

State	Furnace	Foundry
Alabama	2,869,268	108,003
Georgia and Tennessee		2,696
Virginia and West Virginia	1,110	202
Totals	2,870,378	110,901

VALUE.

Quantity (net tons) and value of coke produced in Alabama, 1912-1915.

	1912	1913	1914	1915	Increase or decrease	Percentage		
						Total	Beehive	By-product
Quantity	2,975,489	3,323,664	3,084,149	3,071,811	— 12,338	—0.4	—4.9	+1.9
Value	$8,098,412	$9,627,170	$8,408,443	$8,545,555	+$137,112	+1.6	—7.3	+7.5

Average value, per short ton and percentage yield of coke from coal, in Alabama, 1911-1915.

	1911	1912	1913	1914	1915
Average value	$2.75	$2.72	$2.90	$2.73	$2.78
Percentage yield	62.6	64.9	63.6	65.9	65.4

Quantity and value of coal used in the manufacture of coke in Alabama in 1914 and 1915, and quantity and value of same per ton of coke.

Year	Coal used (short tons)	Total value of coal	Value of coal per ton	Quantity of coal per ton of coke (short tons)	Value of coal to a ton of coke
1914	4,678,196	$6,765,639	$1.45	1,517	$2,200
1915	4,695,938	6,955,215	1.48	1,529	2,263

Coke Ovens.

Coke ovens in Alabama, 1914 and 1915.

Year	Active		Idle		Total		Abandoned	
	Beehive	By-product	Beehive	By-product	Beehive	By-product	Beehive	By-product
1914	2,562	750	*6,006	0	*8,568	750	1,049	.....
1915	2,506	732	6,062	18	8,568	750	.....	.....

*In 1914 Bulletin, these numbers were 33 less due to an omission of 33 idle ovens.

Coke ovens in Alabama at the end of 1911-1915.

Year	Beehive	By-product
1911	9,781	340
1912	9,588	620
1913	9,584	700
1914	8,568	750
1915	8,568	750

Record of by-product ovens in Alabama, 1910-1915.

Year	Built	Building
December 31, 1910	280	340
December 31, 1911	340	280
December 31, 1912	620	100
December 31, 1913	700	20
December 31, 1914	750	0
December 31, 1915	750	0

Complete list of retort coke-oven plants of Alabama, Jan. 1, 1916.

Town	System	Name of company owning plant	Number of installments	Date put in operation	Number of ovens	Uses of coke	Uses of surplus gas
Ensley (near Birmingham)	Semet-Solvay	Tennessee Coal, Iron & R. R. Co.	First	October, 1898	120	Blast furnace.	Fuel.
			Second	March, 1902	120	Blast furnace.	Fuel.
Tuscaloosa	Semet-Solvay	Central Iron & Coal Co.	First	February, 1906	40	Blast furnace.	Fuel.
Tuscaloosa	Semet-Solvay	Central Iron & Coal Co.	Second	1914	20	Blast furnace.	Fuel.
Woodward	Koppers	Woodward Iron Co.	First	1911	60	Blast furnace.	Fuel and power.
Woodward	Koppers	Woodward Iron Co.	Second	1913	80	Blast furnace.	Fuel and power.
Woodward	Koppers	Woodward Iron Co.	Third	1914	30	Blast furnace.	Fuel and power.
Fairfield	Koppers	Tennessee Coal, Iron & R. R. Co.	First	1912	280	Blast furnace.	Fuel and power.

Character of the Coal Used.

Ninety-five and six-tenths per cent of the coal used in the manufacture of coke in Alabama is washed before being charged into the ovens. In 1915 out of a total of 4,695,938 tons of coal made into coke, 4,490,397 tons were washed. Of the washed coal used, 2,968,248 tons were slack and 1,522,149 tons were mine run.

The unwashed mine run coal was 158,480 tons, the unwashed slack was 47,061 tons in 1915.

The character of the coal used in the manufacture of coke in Alabama in 1890, 1900, and for the last six years is shown in the following tables:

Character of coal used in the manufacture of coke in Alabama, 1890-1915, in short tons.

Year	Run of Mine		Slack		Total
	Unwashed	Washed	Unwashed	Washed	
1890	1,480,669	0	206,106	123,189	1,809,964
1900	1,729,882	152,077	165,418	1,535,170	3,582,547
1910	771,931	1,308,085	0	3,192,306	5,272,322
1911	693,135	1,295,109	2,937	2,420,117	4,411,298
1912	747,305	896,421	18,793	2,922,979	4,585,498
1913	868,659	684,223	0	3,665,441	5,218,323
1914	703,241	2,069,638	0	1,905,317	4,678,196
1915	158,480	1,522,149	47,061	2,968,248	4,695,938

Character of coal used in the manufacture of coke in Alabama in 1914 and 1915, in short tons.

Year	Run of mine		Slack		Total			
	Unwashed	Washed	Unwashed	Washed	Unwashed	Percentage	Washed	Percentage
1914	703,241	2,069,638	0	1,905,317	703,241	15.0	3,974,955	85.0
1915	158,480	1,522,149	47,061	2,968,248	205,541	4.4	4,490,397	95.6

Rank of Coke-Producing States.

Coke was produced in 1915 in 22 States; in 5 States only beehive ovens were used; in 10 the whole product came from by-product ovens; and in 7 States both methods of coke making were employed. In total output Pennsylvania heads the list, with Alabama, Indiana, and Illinois following in order. The same States rank highest as regards production from by-product ovens, Indiana, however, leading Alabama in that respect. The rank of the coke-producing States in respect of total and of by-product output for the years 1911-1915 is shown in the following table. Michigan, Ohio, and New York moved up from ninth, eleventh, and twelfth place, respectively, in 1914, to sixth, seventh, and eighth in 1915, by reason of the increased output of by-product coke.

Rank of the States in the production of coke, 1911-1915.

State	1911		1912		1913		1914		1915	
	Total	By-product	Total	By-product	Total	By-product	Total	By-product	Total	By-product
Pennsylvania	1	1	1	1	1	1	1	1	1	1
Alabama	2	5	2	4	2	3	2	3	2	3
Indiana	6	3	3	2	3	2	3	2	3	2
Illinois	4	2	5	3	5	4	4	4	4	4
West Virginia	3	12	4	12	4	12	5	14	5	13
Michigan	12	8	11	8	11	8	9	6	6	5
Ohio	15	11	13	11	14	11	11	9	7	7
New York	8	4	8	5	8	5	12	8	8	6
Colorado	5	.....	6	.....	7	.....	7	.....	9	.....
Virginia	7	.....	7	.....	6	.....	6	.....	10	.....
Wisconsin	9	6	9	6	9	6	8	5	11	8
Kentucky	19	.....	18	.....	16	14	13	11	12	12
Massachusetts	10	7	10	7	10	7	10	7	13	9
New Mexico	11	.....	12	.....	12	.....	14	.....	14	.....
Utah	17	.....	15	.....	15	.....	15	.....	15	.....
Maryland	13	9	16	9	18	10	19	13	16	10
New Jersey	16	10	17	10	17	9	17	10	17	11
Tennessee	14	.....	14	.....	13	.....	16	.....	18	17
Washington	20	.....	20	.....	20	.....	20	15	19	16
Missouri	.....	.....	.....	.....	.....	.....	.....	.....	20	14
Minnesota	18	13	19	13	19	13	18	12	21	15
Georgia	21	.....	21	.....	21	.....	21	.....	22	.....
Kansas	22	.....	22	.....	.....	.....	.....	.....	.....	.....

GOLD AND SILVER.

J. P. DUNLOP AND J. M. HILL.

THERE does not appear to be any record of the first mining in Alabama, but it probably dates from about 1830 or shortly after the gold excitement commenced in Georgia. The estimated production up to 1879 was $365,300, and the yearly output from 1880 to 1903 varied from $1,000 to $8,000 a year. Alabama, unlike most other Southern States, has made its greatest production in recent years from 1904 to 1910, from deep mines, including the Hog Mountain in Tallapoosa County and the Storey in Talladega County.

In 1915 there were mined in Alabama 253.63 ounces of gold, valued at $5,243, and 12 ounces of silver, valued at $6.

The following table shows the mine production of gold, silver, and copper in Alabama since 1905, when the United States Geological Survey first collected detailed figures from the mines of the Eastern States:

Tonnage of ore treated and output of metals in Alabama, 1905-1915.

Year	Ore sold or treated Short tons	Gold*	Silver* Fine ounces	Copper pounds	Total value
1905	16,425	$41,530	336	.....	$41,733
1906	8,565	24,921	124	.....	25,004
1907	18,400	25,982	439	84,678	43,208
1908	11,174	41,208	282	.....	41,357
1909	9,886	29,239	212	.....	29,349
1910	9,763	33,533	268	.....	33,678
1911	6,360	18,916	171	.....	19,007
1912	5,693	16,724	168	.....	16,827
1913	4,068	11,094	117	.....	11,165
1914	5,079	11,970	199	.....	12,080
1915	1,250	5,243	12	.....	5,249
Decrease in 1915	3,829	6,727	187	.....	6,831
Percentage	76.4	56.2	93.9	.....	56.5

*Includes placer gold and silver.

The decrease is due to the closing of the Hog Mountain mines, in Tallapoosa County, which for several years produced most of Alabama's gold and silver. There was very little placer mining during 1915, only a nominal output of placer gold being reported to the Survey. Some prospecting was done on the placer deposits near Arbacoochee, in Cleburne County, but it resulted in no extensive development. The dredge installed there two years ago has been dismantled. Near Chula Finne there was some prospecting for gold quartz. Placer gold was found in a branch on the Tucker farm, 2 miles east of Heflin, and a little sluicing was done in June. The Story mine in Talladega County was operated by the Gold Log Mining Co. The ore is treated in a 10-stamp amalgamating mill.

In the vicinity of Arbacoochee the old placer workings covered a narrow area about 3 miles from east to west along Mud Creek. Much of the work done was on shallow, hillside wash. The material worked was angular quartz carried in a red clay; it is entirely local. The gold in the form of irregular angular nuggets and flakes was evidently derived from the numerous small quartz stringers in the saprolitic schists, and the concentration was practically in place. A little gold was carried into the bed of Mud Creek, which has been worked to the junction with Clear Creek. Clear Creek, so far as could be learned, has not been prospected, though it heads in Turkey Heaven Mountain, in which there are known to be auriferous lodes. It would seem that the saprolite deposits east of Arbacoochee should be tested and that drilling in the angular quartz gravels of Clear Creek, both above and below the mouth of Mud Creek, might reveal workable dredge ground. Above the mouth of Mud Creek the Clear Creek gravels appear to be relatively thin, ranging from 3 to 8 feet thick; below the mouth of Mud Creek the valley widens to about 1 mile and the gravels appear to be deeper. It is said that at the dredge there was 16 feet of gravel and most of the gold was concentrated in the lower 2 or 3 feet. Angular quartz fragments from 2 to 8 inches constitute about 85 per cent of the gravel, the remainder being rather soft schist and slate. This condition is brought about by the soft altered condition of most of the rocks in the vicinity.

GRAPHITE.

By Edson S. Bastin.

Introduction.

THE form of carbon known as graphite or plumbago occurs in nature in a variety of ways and serves many useful purposes, especially in the manufacture of crucibles and other refractory products, in lubricants, as foundry facings, and in stove polishes. Its properties, origin, uses, and mode of occurrence at the principal localities of the United States have been fully described in the report on graphite in Mineral Resources for 1913, which will be sent free on request to the Director, United States Geological Survey, Washington, D. C. That report also contains a bibliography of the more important publications dealing with the general character of graphite and its occurrence in this country.

Because of its use in the manufacture of crucibles, graphite is a mineral resource of vital importance in time of war. The effect of the European war upon the graphite industry in this country in 1915 is very interesting and will be discussed at some length in another part of this chapter. In general the industry was greatly stimulated by the increased demands for graphite products, particularly crucibles, and many American producers of flake graphite reported greatly increased production. Most crucible makers largely increased their output, though unable to take full advantage of the increased demand because of the difficulty in obtaining adequate supplies of graphite of crucible grade. In the mining and concentration of flake graphite particular activity was displayed in Alabama, where one new plant, built in 1914, became an important producer in 1915, and where three new properties are being opened but have not yet reached the producing stage.

Production.

As usual, the greater part of the crystalline graphite was produced by New York, Pennsylvania, and Alabama. The production of these States was all of the variety known in the trade as "flake' graphite, which occurs as small flakes forming

5 to 10 per cent, by weight, of crystalline schists, from which it is separated by more or less complicated milling processes. In addition, a small quantity of crystalline graphite, resembling in a general way the Ceylon graphite, was produced in Montana. As a result of increased production in all these States, but particularly in Alabama, the quantity of crystalline graphite produced in 1915 exceeded that for any previous year. The number of producers of crystalline graphite were 4 in Alabama, 1 in Montana, 3 in New York, and 2 in Pennsylvania.

Four firms produced graphite in Alabama in 1915, the Alabama Graphite Co., the Quenelda Graphite Co., and the Jennings Graphite Co., all near Ashland, in Clay County, and the Flaketown Graphite Co., near Mountain Creek, in Chilton County. The Jennings Graphite Co. began operation late in 1914 and reported an important production in 1915. Its mine is 4 miles west of Lineville; its mill is equipped with an electrostatic separator.

Three new companies have recently begun operations near Ashland, but marketed no graphite during 1915. The Clay County Graphite Co. (Inc.) has a mine and a mill 2 miles north of Ashland. The mill began operation in March, 1916. The Standard Graphite Co., whose office is at Ashland, is developing a graphite property 8 miles west of that place. A mill is in process of erection and the property is expected to begin producing about the middle of 1916. The third company is known as the Southern Graphite Co.; its mine is about 3 miles northwest of Ashland and its mill is now (March, 1916) under construction.

The following table gives a comparison of the production and value of graphite in Alabama in 1914 and 1915:

Production and value of crystalline graphite in Alabama in 1914 and 1915.

	Quantity, pounds	Value	Percentage of total U. S. quantity	Percentage of total U. S. value
1914	2,410,200	$118,000	27.79	*36.41
1915	3,474,800	204,572	36.81	47.61
Increase in 1915	1,064,600	86,572	.....	.....
Percentage	44.2	73.4	.....	.....

*This is Alabama's proportion of the total U. S. value of graphite (amorphous and crystalline), while Alabama's proportion in 1914 represents 41.35 per cent, in 1915 49.02 per cent of the total U. S. value of crystalline graphite.

GEOLOGY AND DISTRIBUTION OF GRAPHITE IN ALABAMA.

By Wm. F. Prouty, Geological Survey of Alabama.

THE crystalline or flake graphite deposits of Alabama are best developed in a comparatively narrow belt extending in a general northeast-southwest direction through portions of Cleburne, Clay, Coosa and Chilton counties.

There are two well marked divisions of this belt. The one to the northeast extends from the extreme northeast corner of Clay county for about 27 miles in a southwesterly direction past Delta, Pyriton, Ashland, to a line drawn from Coleta to Millersville. This area widens toward the southwest.

Between Millerville and Goodwater the flake graphite seems to be largely absent.

The second well-defined belt of flake graphite begins at about Goodwater, in Coosa county, and extends at first to the northwest, thence in a westerly direction, gradually changing to the normal southwest direction through Coosa county between Weogufka and Hanover, past Dollar and Coosa river some five miles, into Chilton County. The graphite rocks probably extend considerably further in the same direction but they are completely concealed by the unconsolidated sands and clays of the cretaceous formation.

The length of the southwest division from Goodwater to a little north of Verbena and Mountain Creek, where it becomes lost under the later sediments, is approximately 33 miles. The area thus has a total length of outcrop, exclusive of the 10-mile strip between Millerville and Goodwater, of about 60 miles. The area has a maximum width, in both divisions, of about four miles.

The area thus defined includes practically all of the known important flake graphite deposits. Occurrences in other areas to the east of this belt have been noted, but they seem to be local developments and, as a rule, rather low in graphite.

The belt is also known to continue to the northeast through Cleburne County and on into Georgia. It is very possible that

portions of this belt may prove to have workable ore, but at the present time such deposits are not known to the author.

The rock in which the flake graphite beds occur is a mica schist, generally considered of pre-Cambrian age, for the most part highly metamorphosed and much intruded by both acid and basic igneous rocks, which are for the most part in long dikes, nearly parallel with the trend of the graphite ore bodies but in some cases cutting them at small angles. Some of the pegmatite dikes have excellent commercial mica and kaolin. Bordering this mica schist on the west, for the entire length of the area, occurs a green colored schist, originally a basic igneous rock and designated by the Alabama Geological Survey the Hillabee schist. The graphite area is seldom more than three miles distant from this metamorphosed basic igneous mass, and locally is in contact with it. The gap in the graphitic area between Millerville and Goodwater is in part due to the extension of the above-mentioned igneous mass into this portion of the field and the cutting out of the mica schist.

The effect of these igneous masses on the associated rocks is in some cases very marked. Secondary minerals of the nature of garnets are often very common bordering the basic intrusions, while muscovite mica occurs frequently in much larger amounts on the border of the granite intrusions.

The number of graphite beds varies greatly in different parts of the field. In portions of the area there are probably more than 15 distinct parallel graphite leads. In some portions of the field these beds are more or less well developed and continuous but elsewhere the beds change rapidly in their character for short distances along the strike. A good workable bed may fall off in graphite content for the whole width of the bed, or the bed may narrow and become too thin to work, or a parting or several partings composed of mica schist, massive quartz or igneous dikes may split the otherwise thick bed into several thin ones, all of which may be too thin to work profitably. The workable portion of some of the beds is, in a number of cases, more than 100 feet thick, but for the most part the workable beds are much thinner, 20 to 60 feet being a common thickness. It is not probable that any of the beds are continuous throughout the entire length of the field, but at different localities in about the same horizon, enrichments of graphite occur which vary considerably in their continuity and value.

Beds Not Evenly Spaced.

The beds of graphite are by no means evenly spaced but occur in fairly well defined groups. The intervening mica schists may have a considerable thickness free from graphite.

While it is not always possible to identify any one particular bed of graphite in different parts of the field, it is usually possible to identify the group to which the bed belongs.

It is concluded from the nature of the occurrence of the graphite beds that they are of sedimentary origin and that the carbonaceous deposits have been charged by metamorphism into the flake graphite deposits. It is noticeable that this metamorphism has been in some cases heightened by the igneous dikes. Frequently the better grade ore is near such masses.

The average content of the workable graphite ore is considerably less than 5 per cent, which is so often mentioned in literature as being the grade of the Alabama ores. A grade of 3.5 per cent seems to be a good average ore. Some deposits with as much as 5 per cent graphite would not pay to work on account of the flake being too small. The larger and firmer the flake, other things being equal, the more valuable the deposit.

In the graphite beds the chief associated mineral is quartz and in many places a white fibrous mineral, probably sillimanitte, is present to a considerable amount. Mica, garnet, and in the unweathered zone, pyrite, are very common accessory minerals.

Depths of Weathering.

The zone of weathering in the graphite beds varies considerable with the locality. In some places 25 to 30 feet would cover the depth of weathering, while in others it has reached to a probable depth of from 80 to 100 feet. In most places 40 to 60 feet is the common depth of weathering, and below this the rock becomes bluer in color, higher in pyrite, and much harder. It is not always true that the greater depths of weathered rocks are to be found on the higher rides. The open structure of the rock, the mineral content and topographic situation are all governing factors which must be taken into consideration.

At the present stage of the milling industry only the weathered or partly weathered rock is run through the mill, since it is more easily crushed and yields a larger flake on account of the less attrition attendant upon its reduction.

Taking the graphite ore from the open pits is a comparatively simple and inexpensive process. Occasional shots are necessary to loosen the rocks, but pick and shovel, quarry bar and sledge are largely employed in getting out the rock and reducing it to sizes suitable for the crushers. It is of great advantage to open the quarry in such places as to avoid excessive stripping and the condition of an overhanging wall. Beds which are vertical or nearly so or which have a dip direction with the slope of the hill offer the most nearly ideal conditions. There is a tendency on the part of the beginner to underestimate the amount of quarry working space necessary to supply ore for a good sized mill, and one should make plans to have sufficient openings to supply the needed ore before going forward with the erection of a large tonnage mill.

Make Sure of Ore Supply.

As is the case in all lines of business in which large profits are being made, speculation is present and parties intending to put up plants for the milling of graphite ore, should first make sure of their ore supply. While locally the beds have considerable continuity, it is never safe to bank on this.

An important fact which it seems necessary to mention is that the character of the ore on a property cannot be told from the analysis of one piece of rock, nor indeed several. The sample to be tested should be representative of the entire width of the contemplated workable seam.

There are several methods employed in the Alabama field at the present time for the reduction of the ore and its separation. Most of the processes are comparatively new and have not yet been perfected. In the reduction of the ore the processes which bring about a gradual reduction in the size of the ore and give the least rubbing of the ore, give the best results by yielding a higher percentage of No. 1 flake and less dust. A gradual reduction by the use of several sets of rolls is coming more into favor.

At the present time most of the mills are employing the wet process of separation by flotation and all but one of these are using water without oil. The dry method of separation has proven successful for certain parts of the field and will doubtless he more used as an auxiliary in the mills using the wet process as time goes on. The electrostatic process for the separation of mica and graphite has also proven locally successful, and with certain changes in the character of the machine to adapt it to local differences of ore could probably be used successfully. It is difficult to tell which of the various processes gives the best results. There is a wide difference at the present time among those using approximately the same method of separation in the percentages of graphite recovered. The efficiency of the washers, for instance, depends on various factors; the dimensions, the rate of flow of the water, the evenness or rate of feed, the condition of the ore, the angle at which the ore hits the water, the character of the ripples, etc. The best results are obtained by those who have most scientifically constructed washers, and who are able to adapt the washer or other separating machinery to the local conditions.

IRON ORE.

EUGENE A. SMITH.

IRON ores of Alabama in the order of their economic importance are (1) red ore or hematite; (2) the brown ore or limonite; (3) the gray ore. The black band and clay iron stone have been noticed as occurring in a number of places, but only the red ore and the brown ore have been mined on any large scale.

Practically all the ore mined in Alabama is smelted in the State, the shipments out of the State being about equal to those received from other States.

The tables given below will show the rank of Alabama among the States of the Union both in the production of iron ore and in pig iron.

Red Ore or Hematite.

All the ore of this quality mined in Alabama occurs in the Clinton or Red Mountain formation. The Red Mountain ridges occur on each side of the anticlinal valleys which separate the coal fields. In places the red ore ridges are lacking on one side, usually the western, of the valleys, being cut out by faults, while on the other hand the ridge may be duplicated on one side of the valley by the same faults.

In most of the valley occurrences the moderate dips of the ore bed are on the eastern side and there are also practically all of the ore mines. Murphree's Valley makes an exception to this, the moderate dips and the iron mines being on the western side. The iron ore occurs mainly in the central part of the formation in seams or beds one to five in number, which vary in thickness from a few inches to thirty feet.

While the ore seams are very persistent along the outcrop which in Alabama must be as much as 50 miles, yet they vary greatly from place to place, being either too thin or too lean for profitable working in the greater part of this distance.

The most important development of the Clinton ore in this State and in the world is along the 15 or 16 miles stretch of the east Red Mountain between Birmingham and Bessemer, and there is a practiacally continuous series of mines and strippings for this entire distance. Much mining of this ore has also been done near Gate City, Village Springs, Attalla, Gadsden, Round Mountain, Gaylesville, Ft. Payne, Valley Head, etc.

The completion in October, 1912, of a diamond drill boring in Shades Valley, within a mile of the base of Shades Mountain, gives a definite answer to the speculations concerning the occurrence of red ore under Shades Valley. This boring shows that there is no falling off in the thickness and quality of the ore with distance from the outcrop, and that the depth of the ore below the surface at a distance of more than 2½ miles from the outcrop on Red Mountain is not too great for shaft mining.

The elevation of the surface at the drilling is 595 feet. The top of the ore was reached at a depth of 1,902 feet and a section of the seam in descending order is:

Ore (self-fluxing)	9 ft. 6 in.
Shale	4 in.
Ore (Siliceous)	9 ft. 6 in.

An analysis of an average sample of the drill core of the upper bench, made by David Hancock, shows as follows:

	Per Cent.
Metallic iron	39.51
Silica	9.94
Alumina	3.34
Calcium Carbonate	24.20
Magnesium carbonate	.78
Metallic manganese	.20
Phosphorus	.32

The importance of this demonstration of a vast increase in the amount of red ore available immediately or in the near future, cannot well be overestimated.

In 1913 the Gulf States Steel Company acquired about 1,500 acres of land upon which the drill hole above mentioned was located. They have since sunk a double track slope to the ore. In time this is likely to be the largest producing mine in the State.

Another drill hole was put down in Shades Valley in 1913, in Section 19, T. 19, R. 3 W., but the records are not available for publication at the present time.

The hematite production in Alabama for 1915 was 4,374,309 long tons, as against 3,902,567 tons in 1914, an increase of 471,742 tons or 12.1 per cent.

This 1915 production of hematite is 82.4 per cent of the total iron ore production of the State, and 8.4 per cent of the total iron ore production of the United States.

The average price of hematite in Alabama in 1914 was $1.21: in 1915, $1.25.

Brown Ore or Limonite.

This ore, the second of importance in the State and third in the United States, furnished only 1.7 per cent of the total iron ore production of the United States and 17.6 per cent of the iron ore production of the State in 1915. The entire limonite production of the United States in 1915 was 1,488,709 long tons of which Alabama contributed 935,045 tons or 62.8 per

cent, and the State holds accordingly the first rank in this industry.

In the early days of iron making and up to the year 1876 this was the only ore used in the catalan forges, bloomaries, and charcoal furnaces of the State. It was then demonstrated that good iron could be made at low cost from the red ores, with coke for the fuel.

In general the limonites are considered the best of the ores of Alabama and they command the highest prices and command a ready sale.

The usual mode of occurrence is in irregular masses of concretionary origin in the residual clays resulting from the decomposition of limestones, and as a consequence the mining is uncertain and expensive. Limonite also occurs in regularly stratified seams or beds, and then it is the result of the alteration of pyrites or of carbonate ores. Practically all of the brown ore actually mined is that occurring in the residual clays above mentioned. Most of the ore before going to the furnace is washed and screened, and this manipulation, together with the cost of mining, makes it the most expensive of the iron ores, and it is therefore seldom used alone, but is usually mixed with the red ore in proportions determined by the quality of the iron desired. It is used alone in the charcoal furnaces and also in the coke furnaces when a particularly tough pig iron is wanted.

The limonite deposits are very numerous and are distributed over a broad expanse of country and in many places are known to be very extensive. In some of the deposits the ore is in nearly solid mass, in others it is much scattered, and in consequence the amount of foreign material necessary to be moved for every ton of ore produced, varies very much, not only in the different ore banks, but also in the different parts of the same bank.

The deposits occur in nearly all the geological formations of the State, but in most of these the ore is either insufficient in quantity or not pure enough to be of much commercial value. The most important of the deposits, in point of extent and value, occur overlying the following formations, viz., the Knox Dolomite and the Weisner Quartzite, the Lauderdale Chert of the Lower Carboniferous, and the Lafayette. Some extensive beds of ore of inferior quality generally occur also

in the Tuscaloosa formation of the Cretaceous, and in the upper part of the Lower Carboniferous and in the Metamorphic rocks.

The limonite or brown ore production of Alabama in 1915 was 935,045 long tons as against 936,392 tons in 1914, a decrease of 1,347 tons, or .14 per cent.

The average price per long ton of brown ore marketed in Alabama in 1915 was $1.68, as against $1.49 in 1914.

Details of Iron Ore Production In Alabama, 1915.

The following tables show details concerning the production of iron ore in the State, together with the rank of the State in mined and marketed iron ore in 1914 and 1915:

Iron ore mined in Alabama, 1914-1915, by varieties, with percentage of increase in 1915 in long tons.

Year	Hematite	Brown ore	Total quantity	Percentage of total U. S. produc'n
1914	3,902,567	936,392	4,838,959	11.68
1915	4,374,309	935,045	5,309,354	9.74
Increase or decrease	+ 471,742	— 1,347	+ 470,395	.....
Percentage	+ 12.1	— 0.1	+ 9.4	.....

Iron ore marketed in Alabama in 1914 and 1915, by varieties, in long tons.

Year	Hematite	Brown ore	Total quantity	Total value
1914	3,589,809	925,117	4,514,926	$5,727,619
1915	4,199,910	935,045	5,134,955	6,798,266
Increase in 1915	610,101	9,928	620,029	1,070,647
Percentage of increase	16.9	1.1	13.7	18.7

Average price per gross ton of iron ore shipped from mines in Alabama and the United States, 1914-1915.

	Hematite		Brown Ore	
	1914	1915	1914	1915
Alabama	$1.21	$1.25	$1.49	$1.68
United States	1.79	1.80	1.72	1.80

Rank of the first five states in mined and marketed production of iron ore in 1914 and 1915.

1914

Rank	State	Mined		Marketed			
		Quantity (long tons)	Percentage of total production	Quantity (long tons)	Percentage of total production	Value	Percentage of total value
1	Minnesota	21,946,901	52.96	23,298,547	58.66	$40,628,771	56.50
2	Michigan	10,796,200	26.05	8,533,280	21.49	18,722,358	26.04
3	Alabama	4,838,959	11.68	4,514,926	11.37	5,727,619	7.97
4	Wisconsin	886,512	2.13	591,595	1.49	1,178,610	1.64
5	New York	785,377	1.90	640,252	1.61	1,992,892	2.77

1915

1	Minnesota	33,464,660	60.27	32,545,236	58.63	$57,742,643	57.01
2	Michigan	12,514,516	22.54	13,664,437	24.63	28,218,627	27.86
3	Alabama	5,309,354	9.74	5,314,955	9.76	6,798,266	6.71
4	Wisconsin	1,095,388	1.97	1,125,269	2.03	2,188,012	2.16
5	New York	998,845	1.79	931,745	1.68	2,797,270	2.76

Principal Iron Ore Mines.

In 1914 and 1915 there were three hundred and forty iron ore mines active in the United States as compared with 411 in 1913, and 184 mines produced more than 50,000 long tons of ore each in 1915, as compared with 164 mines in 1914.

The Red Mountain group of red hematite mines in the Birmingham district, Alabama, led in 1915, with an output of 2,138,015 long tons of ore, this quantity is nearly 130,000 tons more than the output of this group in 1914. Six of the seven mines producing more than 1,000,000 tons each in 1915 are in Minnesota.

Iron ore mines of Alabama that produced more than 50,000 long tons each in 1915.

Rank.	Name of Mine	Nearest Town	Variety of Ore	Quantity
1	Red Mountain Group	Bessemer	Hematite	2,138,015
2	Woodward, 1, 2 and 3	Lipscomb	Hematite	880,737
3	Raimund No. 1	Bessemer	Hematite	221,955
4	Songo	Songo	Hematite	210,369
5	Greeley	Greeley	Brown Ore	157,914
6	Steinman	Steinman	Hematite	125,133
7	Raimund, No. 2	Bessemer	Hematite	118,911
8	Attalla	Attalla	Hematite	88,712
9	Friedman	Woodstock	Brown Ore	81,684
10	Ironaton	Ironaton	Brown Ore	77,870
11	Houston	Rickey	Brown Ore	77,453
12	Raimund, No. 3	Bessemer	Hematite	74,563
13	Tannehill	Goethite	Brown Ore	70,991
14	Docray	Docray	Brown Ore	56,729
15	Champion	Oneonta	Brown Ore	55,427

*Includes the product of three mines, producing over 50,000 tons each, operated by two companies which do not permit the publication of individual statistics.

Total 15 mines	4,436,463
Unspecified (3 mines)	753,548
Tonnage from 18 mines producing over 50,000 tons	5,190,011
Tonnage from 12 mines producing less than 50,000 tons each	119,343
Grand total of Alabama production	5,309,354

PIG IRON.

Quantity and value of pig iron (exclusive of ferro-alloys) marketed in the United States in 1914 and 1915 (first five states) with increase and percentage of increase in 1915, in long tons.

	1914		1915		Increase in 1915		Percentage of increase in 1915	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1. Pennsylvania	9,267,197	$127,686,331	12,779,974	$174,926,891	3,512,777	$ 47,240,560	37.9	36.9
2. Ohio	5,226,925	70,331,114	6,995,000	90,549,626	1,768,075	20,218,512	33.8	28.7
3. Illinois	1,793,714	24,382,458	2,455,894	34,207,901	662,180	9,825,443	36.8	40.3
4. Alabama	1,661,420	17,481,828	2,320,255	23,757,124	658,835	6,275,296	39.6	35.9
5. New York	1,357,575	19,353,309	2,010,076	28,178,466	652,501	8,825,157	48.1	45.6

Average price per gross ton of pig iron in Alabama and the United States, 1911-1915.

	1911	1912	1913	1914	1915
Alabama	$10.75	$10.75	$12.08	$10.52	$10.24
United States	14.07	13.93	15.08	13.42	13.21

LIME.

EUGENE A. SMITH.

DURING the year 1915 there was an increase in the production of lime in Alabama, as compared with the production of the preceding year. The total product of 14 operators in 1915 was 60,332 short tons, an increase from the 1914 production of 13,366 short tons or 28.4 per cent. The value of the product was $250,227, an increase of $50,413, or 25.2 per cent.

As heretofore, the most important use of the lime produced was for building purposes. 21.8 per cent of the State's total production is definitely so accredited in the returns, which added to the 10.4 per cent in the form of hydrated lime, produced by 3 operators, give 32.2 per cent definitely assigned to building purposes. Of the 66.4 per cent sold to dealers, uses not specified, a large proportion undoubtedly goes for building purposes, so that probably more than 50 per cent, possibly 75 per cent of the product is thus used. Other chief uses for lime are in chemical works, paper mills, soap factories, manufactories of sand-lime brick, slag cement, etc.

Shelby County, as heretofore, was the largest producer in 1915, having produced 41,883 tons, or about 70 per cent of the total. The other producers in the order of their rank, were Blount, Etowah, Jackson, and Jefferson.

The following tables present some additional data on the lime production in Alabama in 1914 and 1915:

Production of lime, 1914 and 1915.

	Number of operators	Quantity (short tons)	Rank of state by quantity	Value	Rank of state by value	Average price per ton	Percentage of total U. S. value
1914	12	46,966	17	$199,814	18	$4.25	1.5
1915	14	60,332	16	250,227	17	4.15	1.4
Increase	2	13,366	.....	50,413	.....	.....	.....
Percentage	17	28.4	.....	25.2	.....	.....	.....

Number of lime kilns in Alabama using various kinds of fuel in 1914 and 1915.

Year	Coal	Producer gas	Wood	Coal and Wood	Total number of kilns
1914	8	8	10	9	35
1915	*6	8	8	20	42

*5 coal and 1 coke.

Those interested in the subject of lime are referred to an article on Lime by Ralph W. Stone of the U. S. Geological Survey, and on the Source, Manufacture, and Use of Lime, by E. F. Burchard and Warren E. Emby of the U. S. Geological Survey, in Vol. II of the Mineral Resources of the United States for 1913, and to the section on Lime by G. F. Loughlin, in Mineral Resources of the United States for 1915.

MICA.

MICA mines were opened in Alabama during the early days of mica mining in the Southern States. Prospects have been tested at various subsequent times, and considerable mining has been carried on at intervals during the last 20 years. The mines are located in Randolph, Cleburne, Clay, and Tallapoosa counties, and there are prospects in Lee, Coosa, Chilton and other counties.

In 1915 there were four mines producing mica. The output was 8,400 pounds of sheet mica valued at $5,545, also several hundred dollars worth of scrap mica.

MINERAL WATERS.

R. B. DOLE.

RETURNS from Alabama indicate that the mineral-water trade in 1915 was little more than half that in 1914. The sales amounted to 86,499 gallons, and the value of the output was $8,912, the average price per gallon, 10 cents, remaining the same. The decrease was chiefly in sales of table waters. Fourteen springs reported sales; four springs regarding which no reports have been received for two years have necessarily been considered idle. Four mineral-water bathing establishments and five resorts accommodating about 650 guests were maintained. A small amount of mineral water also was used in the manufacture of soft drinks.

The following 14 springs reported sales:

Bailey Springs, Florence, Lauderdale County.
Bladon Springs, Bladon Springs, Choctaw County.
Bromberg Gulf Coast Lithia Spring, Bayou Labatre, Mobile County.
Cooks Springs, Cooks Springs, St. Clair County.

Dixie Spring, Dixie Spring, Walker County.
Healing Springs, Healing Springs, Washington County.
Ingram Lithia Well, near Ohatchee, Calhoun County.
Livingston Mineral Spring, Livingston, Sumter County.
Luverne Mineral Spring, Luverne, Crenshaw County.
McCary Mineral Well, near Birmingham, Jefferson County.
Matchless Mineral Wells, east of Greenville, Butler County.
Purity Spring, Spring Hill, Mobile County.
Shocco Spring, Talladega, Talladega County.
White Sulphur Wells, near Jackson, Clarke County.

The following table shows the relative productions and their respective values of mineral and table water in 1914 and 1915:

Production and value of mineral and table waters sold in 1914 and 1915.

	Number of springs reporting	Quantity sold (gallons)	Average retail price	Total value of mineral waters	Percentage of total U. S. value
1914	15	169,279	.10	$17,125	0.35
1915	14	86,499	.10	8,912	0.17
Decrease	1	82,780	.....	8,213	.....
Percentage	6.6	48.3	.....	47.9	.....

The quantity of water used in the manufacture of "soft drinks" in 1914 was 86,500 gallons; in 1915, 2,300 gallons.

NATURAL GAS.

JOHN D. NORTHROP.

THE natural-gas industry in Alabama is of little consequence. In 1915 natural gas in sufficient quantities to supply the needs of 291 consumers in the town of Fayette was obtained from three wells in the Fayette gas field, Fayette County, and enough for the needs of 150 consumers in the town of Jasper was obtained from two wells in Walker County. In the Fayette field the wells range in depth from 1,400 to 1,440 feet. In the Walker County field gas is ob-

tained at a depth of 1,800 feet. One gas well was drilled in the Fayette field in 1915.

Because of the small number of producers, the statistics of production and consumption of natural gas in Alabama cannot be given, without revealing confidental data furnished by individual companies.

OCHER.

JAMES M. HILL.

OCHER is a hydrated ferric oxide permeating a clay base. It has a specific gravity of about 3.5 and a decidedly golden-yellow color. As viewed under the microscope and with considerable enlargement the particles composing ocher appear flocculent and uniform. Good grades should contain 20 per cent or more of iron oxide, though there is a wide variation in the iron content of the material sold as ocher. Ferruginous shale is often ground and the product marketed as ocher, but unless the material is actually an ocher, as defined above, such product is classed under slate and shale in this chapter.

In 1913 ocher was produced in Georgia, Pennsylvania, Virginia, Alabama, California, Iowa, and Vermont, the States being named in the order of their producing importance. In 1913 Alabama re-entered the class of ocher producers, a new mine being opened in Clarke County.*

Since the beginning of the European war domestic ochers have been more used than heretofore. It is the general opinion among the users of this pigment that the domestic ocher does not compare with the French ocher in tone, color, or strength. It seems to be the case, as in many American industries, that the producers will not prepare their materials with the care used by the foreign manufacturers. It is the belief of the writer that some domestic ochers could be made equal to the French ochers in every respect if American producers would

*This mine was the only producer of ocher in 1915, but there are many promising deposits of ocher in Alabama, especially in the area of the Tuscaloosa formation of the Cretaceous, as well as in other parts of the Coastal Plain southward nearly to the Gulf.—E. A. S.

give more attention to the details of cleaning and floating. It has been said of American ochers† that, "by skillful handling, a thoroughly satisfactory color can be obtained. This is done by tinting the ocher with American chrome yellow until the correct shade is obtained."

PETROLEUM.

By Eugene A. Smith.

OCCURRENCES of tar springs, bituminous limestones, and bituminous sandstones in the Tennessee Valley, have been reported as far back as the time of Prof. Tuomey, the first State Geologist, and many notices of these things have appeared in subsequent reports of the Geological Survey, especially the Report on the Tennessee Valley Region by Mr. Henry McCalley. In this report will also be found somewhat full accounts of the Goyer wells, put down in the Moulton Valley some time in the early part of '91. From these wells small quantities of oil were obtained and the report above named gives some analyses of the oil. In the same report are accounts of deep wells near Hartselle, Newmarket and Huntsville, from some of which small amounts of oil were obtained. Later borings in the mineral district of North Alabama have obtained some small quantities of oil; as at Bryan station in Jefferson County, Jasper in Walker and Cordova, also in Walker. The last named boring struck a small pocket of oil at the depth of 835 or 840 feet during the latter part of December, 1916. Other borings further north at Hamilton in Marion County, and Atwood in Franklin County, have also yielded oil-saturated sands and small quantities of oil. Some of the drillings also in the Fayette County gas field have passed through oil sands, according to report.

In South Alabama, around the Hatchetigbee anticlinal in Choctaw, Washington and Clark counties, there have been several deep borings after oil, but none in any commercial quantity has yet been brought in.

†Paint, Oil, and Drug Rev., vol. 58, p. 4, Sept. 16, 1914.

The striking of the oil pocket at Cordova in December, 1916, which yielded oil in quantity measurable by the barrel, has greatly stimulated the search for oil in Alabama, and companies are now, (March, 1917), quite active in nearly all parts of the State. There seems, therefore, to be no reason to doubt that in the next 12 months we shall be able to class Alabama as one of the oil-producing states.

SAND AND GRAVEL.

THE total production of sand and gravel in the State in 1915 was 924,701 short tons, valued at $242,336, as compared with 831,430 tons, valued at $262,219 in 1914, an increase in quantity of 93,271 tons or 11.2 per cent, and a decrease in value of $19,883 or 7.6 per cent.

There was an increase in the quantity of sand of 73,506 short tons or 24.2 per cent, and in value of $2,138 or 1.7 per cent.

In the quantity of gravel there was an increase of 3.7 per cent, and a decrease in the value of 15.9 per cent.

Over 42 per cent of the sand was used for building purposes.

The following tables give a comparison of the production of sand and gravel in 1914 and 1915, and the production, value and disposition of the sand in these two years.

Production in short tons of sand and gravel in 1914 and 1915.

	Sand		Gravel		Total*		Percentage of total U. S. value
	Quantity	Value	Quantity	Value	Quantity	Value	
1914	303,539	$123,526	527,891	$138,693	831,430	$262,219	1.10
1915	377,045	125,664	547,656	116,672	924,701	242,336	1.05
Increase or decrease	+73,506	+ 2,138	+19,765	—22,021	+93,271	—19,883	
Percentage	+ 24.2	+ 1.7	+ 3.7	— 15.9	+ 11.2	— 7.6	

*Chert has been added to these totals.

Production (in short tons), value and kinds of sand in 1914 and 1915.

	Moulding Sand		Building Sand		Grinding and Polishing Sand		Fire Sand		Paving Sand		Engine Sand		Other Sand		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1914	92,551	$43,702	152,800	$51,792	8,052	$4,104	22,135	$6,450	5,849	$4,538	12,040	$3,127	10,112	$9,813	303,539	$123,526
1915	169,663	59,862	157,581	51,788	*	*	*	*	*	*	6,942	1,779	7,294	2,180	†377,045	125,664
Increase+ or Decrease—	+77,112	+16,160	+4,781	—	4						—5,098	—1,348	—2,818	—7,633	+ 73,506	+ 2,138
Percentage	83.4	37.0	3.6	.001							42.3	43.1	27.9	77.7	24.2	1.7

*Concealed because of less than three producers.
†Including "Concealed Totals."

SILICA (QUARTZ).

By Frank J. Katz.

Uses.

SILICA (quartz) as discussed in this chapter is used for many purposes, principally in the manufacture of pottery, paints, and scouring soaps, as a wood filler, as a polisher, and in metallurgical and chemical processes. In the pottery industry, where it is generally called flint, silica is used in the body of the ware to diminish shrinkage and is also used in glazes. Silica for use in pottery should contain less than 0.5 per cent of iron-bearing minerals. Manufacturers of paint use considerable quantities of very finely ground silica, which forms as much as one-third of the total pigment in some paints. For this purpose finely ground crystalline material is superior to fine sand in its natural state because of the angularity of the grains, which makes them adhere more firmly to the article painted and after wear affords a good surface for repainting. The same angularity makes artificially comminuted crystalline quartz superior to natural sand for use in wood fillers. For soaps and polishing powders ground material is preferred to natural sand on account of its whiteness and angularity. For all these purposes large quantities of pure quartz sand and standstone are finely ground and yield a product fully equal to that obtained by grinding massive crystalline quartz.

The material known commercially in the United States as tripoli, which is the siliceous residue of decomposed limestones, also yields an excellent grade of pulverized silica, which is used for the same purpose as silica powder obtained from massive crystalline quartz and from sands and sandstones. Diatomaceous (infusorial) earth is also used to make polishing powder that is employed for similar uses to those for which quartz, sand, and tripoli powders are employed, but diatomaceous earth has somewhat different properties and most of it finds different application.

Quartz crushed and graded to various sizes is used in making sandpaper and sand belts, as a scouring agent, for "frost-

ing" glass with sand-blast apparatus, and for other purposes. Blocks of massive quartz and quartzite are used in the chemical industry as a filler for acid towers and as a flux in copper smelting. Ground quartz is also used in filters and in tooth powders and by dentists as a detergent.

Sand and crystalline quartz have been used in making silicon and alloys of silicon with iron, copper, and other metals in the electric furnace. Quartz may be used in the electric furnace to make chemical apparatus, such as tubes, crucibles, and dishes.

Production.

In Alabama one firm made an initial production of sandstone near Trussville, Jefferson County, from property acquired late in the year and reported that a mill for grinding would be put into operation.

STONE.

Eugene A. Smith.

ON ACCOUNT of the variety of uses to which stone is put, there is no regular unit of measurement, and the figures in this report represent the values of the different varieties.

Production.

Alabama produces only three kinds of stone, viz., limestone, marble, and sandstone.

The total value of the production of stone in Alabama showed a decrease in 1915 of 45.5 per cent. The greater part of this decrease was in the limestone (rough building stone, crushed stone for road making, and concrete,) and for agricultural purposes. The standstone also showed a decrease. There was also a notable decrease in the value of the marble produced. Eact figures for marble, however, cannot be given except for the year 1914, since before 1914 there were less than three producers.

The following table gives some additional details concerning the total stone production:

Total value of stone (limestone, sandstone and marble) produced in Alabama in 1914 and 1915, percentage of total U. S. value, rank of state and number of plants.

Year	Total Value	Percentage of total U. S. value	Number of Plants	Rank of State
1914	$1,319,753	1.71	38	22
1915	719,452	.96	25	28
Decrease in 1915	600,301			
Percentage	45.5			

LIMESTONE.

The most important use of the limestone produced in Alabama in 1915 as in 1914 was for furnace flux, while crushed stone for road-making and concrete follow next in importance. A very decided decrease in the amount of ground limestone for agricultural purposes, is to be noted.

The limestone burned into lime or used in the manufacture of Portland cement is not taken into account here, but is included in the value of each of the finished products in whose manufacture it was used.

As thus limited the total value of the limestone produced in 1915 was $426,266, as compared with $787,214 in 1914, a decrease of $360,948, or 45.9 per cent.

The value of the limestone produced in 1914 and 1915 classified according to the uses of the stone, are given in the following table:

Value of limestone (not including marble) produced in 1914 and 1915, according to uses.

Uses	1914	1915	Increase or Decrease	Percentage
Rough building	$20,992	$6,912	— $14,080	— 67.1
Dressed building	20,558	15,487	— 5,071	— 24.7
Rubble		800		
Riprap	3,882	18,379	+ 14,497	+ 373.4
Crushed Stone:				
Road making	75,528	42,116	— 33,412	— 44.2
Railroad ballast	1,076	554	— 522	— 48.5
Concrete	287,119	45,443	— 241,676	— 84.2
Flux	360,691	289,167	— 71,524	— 19.8
Agricultural	17,365	7,386	— 9,979	— 57.5
Other		22		
Total	$787,211	$426,266	—$360,948	— 45.9

Limestone for Building Purposes.

The preparation of cut stone for building purposes in Alabama, while on the increase, is not yet what it should be. Practically all of this material comes from the quarries in the subcarboniferous limestone of the Tennessee Valley, the most important quarries being at Rockwood in Franklin County, operated by Foster and Cheighton Co., of Nashville. This stone is quite similar in appearance, composition, and other qualities to the Indiana stone, and so far as experience in the use of the stone from the two localities in the buildings of the University of Alabama goes, the Alabama stone holds its own under influence of the weather better than does the Indiana stone. Stone steps, door sills, and window sills, buttress caps, etc., of the Alabama stone put in place in 1885 show practically no deterioration in color and wear under foot, and in crumbling and roughening under the influence of the weather, which cannot be said of some portions of the Indiana stone used in buildings erected in 1909-10. The Rockwood quarries have most modern and approved methods of machinery for sawing the stone and handling it in transit to the mills and elsewhere. The stone is of massive formation, of great thickness and extent. Blocks weighing as much as 25 tons, without crack or flaw, are not infrequently quarried, the size of the blocks being practically limited only by the capacity of the hoisting machinery.

The Oolitic variety is most extensively used for building and monumental work. It is of light gray color, uniform grain, and homogeneous texture. It possesses a quality of cheapness, it can be cut to any design required, and is at the same time strong and durable.

With the installing of adequate machinery at the quarry for doing the finished work, there should never be any longer any reason for going outside of the State for this quality of stone. Already the material has been very extensively used in public buildings in Mississippi, Tennessee, as well as in Alabama. The only reason why it was not used in the recently erected buildings at the University of Alabama was that at the time these building contracts were let, the quarries furnished only the rough sawn stone and there was not in Alabama any establishment adequately equipped for the dressing of the stone in the quantity needed.

The above statements are confirmed by a report on the comparative tests made on the Rockwood stone, and those from Bedford, Ind., and Bowling Green, Ky., by Prof. Robert H. McNeilly, in the Engineering Laboratory of Vanderbilt University.

From this report I give the following extracts:

"GENERAL CHARACTERISTICS.—The Rockwood limestone is an almost pure oolitic limestone with frequent small crystals of calcite distributed throughout its mass. It resembles closely the Bedford stone in appearance, except that it has a slightly more open texture. The Bowling Green stone is finer in grain, softer and more easily pulverized than either the Bedford or Rockwood stones, and contains an appreciable amount of petroleum, which lends somewhat to the ease with which it is worked. In all three stones the texture is exceptionally uniform, as it is almost impossible to detect the bedding planes by eye; however in this respect the Bowling Green stone is most marked, and it is frequently necessary to test by hammer to detect which is the bed plane. Rockwood stone is lighter in color than either the Bedford or Bowling Green stones.

"CHEMICAL ANALYSIS.—The following is an analysis of the Rockwood stone made at my request by Dr. Paul C. Bowers, Chief Chemist of the Tennessee Geological Department:

	Rockwood Stone.
Moisture and loss on heating to 175° C.	0.07
Insoluble siliceous residue (SiO_2, etc.)	0.49
Oxide of Iron and Alumina (Fe_2O_3 & Al_2O_3)	0.30
Carbonate of Lime ($CaCO_3$)	98.23
Carbonate of Magnesia ($MgCO_3$)	0.97
Total	100.06

"PHYSICAL TESTS.—Comparative physical tests of the three samples of stone were made as follows:

Loss in weight on drying,
Cross bending tests,
Compression tests,
Absorption tests,
Per cent of water absorbed,
Specific gravity in bulk, and of pulverized stone,
Density,
Abrasion tests.

The results of these physical tests are summarized in the CONCLUSIONS below quoted.

"CONCLUSIONS.—The above tests were made as nearly as possible, under identical conditions, and barring the accidental characteristics of the samples, which were selected at random, these results are believed to represent truly the comparative characteristics of each of the stones under consideration.

"The Rockwood Stone shows itself to be a superior building stone to others in every respect except density—but even here, since its absorption of water is the lowest of the three, it should prove more durable, while the smaller weight per cubic foot can be placed more cheaply on account of freight charges.

"As compared with the Bowling Green stone, the Rockwood shows a decidedly higher strength, and characteristics which indicate a greater durability. The Bowling Green stone, however, is undoubtedly more easily worked than either of the other two stones, due to its being softer and also to the presence of oil. This oil has the bad effect of staining the stone itself and the contiguous masonry for several years after it is placed, while the very ease with which the stone can be worked makes the Bowling Green very inferior where used for door sills and steps. This is shown well by the Abrasion Test which shows the Rockwood stone in its best light, as a very superior material for steps, door sills, and other places subject to wear.

"From my examination of these three stones, I believe no builder would make a mistake in using any one of the three, for they are all unquestionably very superior building stones. While each stone may have advantages over the other for some specially desired characteristics, as a building stone for general purposes, each is highly satisfactory.

Respectfully submitted,
ROBERT H. MCNEILLEY,
Assistant Professor of Civil
Engineering, Vanderbilt University."

MARBLE.

The marble of Alabama is of two kinds, crystalline, or true marble, and non-crystalline.

The crystalline or statutary marble occurs mainly in a narrow valley along the western border of the metamorphic area, extending from Marble Valley in Coosa County, through Talladega into Calhoun. The length of the marble belt through

Coosa and Talladega counties is about 50 miles. The width of the valley carrying the marble as a rule is from one quarter to one-half mile, widening in places to a mile and a quarter, for example in the neighborhood of Sylacauga.

The quarries longest known are Gantt's and Herd's near Sylacauga, Nix's near Sycamore, Bowie's near Rendalia, and Taylor's and McKenzie's near Taylor's Mill, east of Talladega. From all of these marble was quarried before the civil war.

During 1915 two companies reported production of marble in Alabama, viz., the Alabama Marble Company at Gantt's Quarry and the Moretti-Harrah Company, whose quarry adjoins that of the Alabama Marble Company at Gantt's. The other quarries mentioned are in Talladega county, near Sylacauga.

The plant of the Alabama Marble Company at Gantt's Quarry which was completely destroyed by fire in December, 1910, has been rebuilt and equipped with all the machinery needed for the working up of any kind of finished product.

I think it is fairly safe to say that on the whole the marble from this quarry and immediate vicinity is of the highest grade of commercial white marble now on the market and obtainable in large quantity. There are small quantities of marble produced both in Italy and Vermont that are somewhat freer from coloring matter than the best grades that can be produced in Alabama in any quantity. But on the other hand, the poorest grades in Alabama greatly surpass the poorest grades produced elsewhere, so that the average of the Alabama deposit is probably somewhat higher than that of any other so far developed, not excluding even the marble from the Carara district in Italy. The marble from this State (Gantt's Quarry) has now a well established reputation and has been used in more than 200 important buildings throughout the United States.

It can be seen in the galleries of the National Museum in Washington.

The Moretti-Harrah Company furnishes the marble in blocks for monumental and rough interior purposes.

A beautiful quality of variegated limestone or marble—red, pink and white—belonging probably to the Cambrian formation, occurs in Shelby County, a mile or two south of Shelby Springs station on the L. & N. railroad, and extending thence

southwest for a mile or two. Nothing but prospecting work has been done on this marble. The Trenton limestone in the Appalachian valleys, particularly Jones Valley below Bessemer, contains marble similar to that quarried in the vicinity of Knoxville, Tenn. Also as to Pratt's Ferry on the Cahaba River in Bibb County a quarry was for many years worked in this formation and turned out a very beautiful quality of marble varying in color from gray through pink, red and brown shades.

A black marble which is exceedingly promising, has been reported and some development work done near Anniston, and at Piedmont, Calhoun County, and some very handsome specimens of cave onyx have been obtained from near Kymulga in Talladega County.

In the Coastal Plain the St. Stephen limestone of the Tertiary holds ledges of hard, almost crystalline rock capable of taking good polish. The colors vary from nearly white, through shades of yellowish into red, and it would make a handsome decorative marble, especially for inside work.

Other limestone formations, such as the Subcarboniferous and the Knox Dolomite, could in places be drawn upon for marble.

SANDSTONE.

As may be seen in the tables below, the production of sandstone in 1915 shows a decrease in total value of $131,341, or 81.2 per cent as compared with 1914.

Value of sandstone production in Alabama, 1914 and 1915, according to uses.

Use	1914	1915	Increase or Decrease	Percentage
Rough building	$57,079	$150	— $56,929	— 99.7
Ganister	2,300	4,500	+ 2,200	+ 95.7
Rubble	1,558	13,327	+ 11,269	+ 755.4
Riprap	15,694	12,455	— 3,239	— 20.7
Crushed stone—concrete	85,142	.....	.....	.....
Total	$161,773	$30,432	—$131,341	— 81.2

Value of limestone and sandstone production in Alabama, 1911-1915.

Kind	1911	1912	1913	1914	1915
Limestone	$571,798	$531,085	$812,664	$787,214	$426,266
Sandstone	73,195	27,596	151,111	161,773	30,432

SUMMARY.

BECAUSE of the difference in the units of measurement employed in the various branches of the mineral industry, a summation of the production of the year can include only the values of the products. It is also to be noted that a simple summation of all the values of the minerals or mineral products listed in this pamphlet would give a value much in excess of the true value, since it many cases, as for instance, coal and coke, and iron ore and pig iron and steel, the second product is directly a product of the first, and the value of the first is included in that of the second. To give the values of both as a part of the total would be to repeat, in a measure, at least a partial value of the first or raw product, and would give an erroneous result.

As the Survey has not, however, the figures upon which to base an estimate as to the percentage of each product which was used in the manufacture of some other product, the summation of the mineral production of the State, as given here, will be a simple summation of the values reached by the individual branches of the industry.

According to this rather unsatisfactory manner of summation, which does not include the value of the steel produced, the value of the 1915 raw materials and immediately derived products, was $61,760,086, as compared with $56,769,559 in 1914 an increase of $4,990,527 or 8.78 per cent.

This production may be classified as follows:

Raw Products	$29,457,407
Pig Iron	23,757,124
Coke	8,505,555
Total	$61,760,086

The more important minerals and products after coal, pig iron and coke, are iron ores, clay products, stone, cement, sand and gravel and lime, given in the order of their relative value.

Below is a tabular presentation of the value of the mineral products of Alabama, as estimated above for the years 1911, 1912, 1913, 1914, and 1915.

Year.	Value.
1911	$52,772,951
1912	60,141,793
1913	67,530,089
1914	56,769,559
1915	61,760,086

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